Leeds & Northrup Instruments

Catalog of Instrumentation

Adding new dimensions to industrial instrumentation and control

LEEDS & NORTHRUP COMPANY
A UNIT OF GENERAL SIGNAL

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UPDATED 4-1-90

Leeds & Northrup

Instruments & Systems for Process Measurement and Control

Product Directory

Leeds & Northrup

Instruments & Systems for Process Measurement and Control

Temperature. . .pressure. . .flow. . .pH. . .conductivity. . .gas concentration—these are only a few of the many process variables that Leeds & Northrup instruments have been measuring and controlling in thousands of applications throughout the world. In Leeds & Northrup's broad spectrum of innovative instrumentation you'll find state-of-the-art process management equipment, both hardware and software; integrated data acquisition and control equipment; exciting technical developments in sensors, analyzers, controllers, recorders and instrument-calibration products—all designed to give you assured performance reliability. . .superior measurement and control accuracy. . .outstanding economic value. By choosing L&N products and services, you'll benefit from L&N's over-85-years of extensive experience developing and applying dependable instrumentation to a wide variety of industrial processes.

In this directory you'll find brief descriptions of standard L&N products and services. In order to keep the entries short, we've included only the major characteristics of each product or service. For each entry, we've also included the number of its detailed data sheet or other source of information. To obtain this information, just contact your nearest L&N Sales & Service Office or representative.

Instrument and
System Solutions!

Leeds & Northrup

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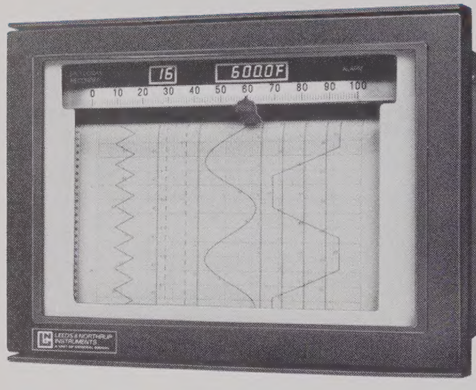
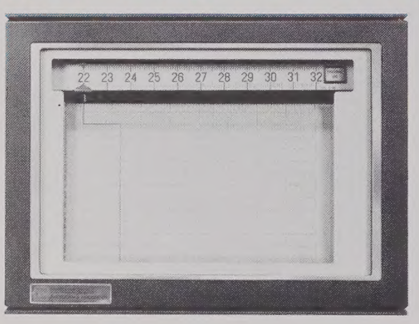
SPEEDOMAX® 1650/2500 Multipoint Recorders



Our widely-used SPEEDOMAX 1650 (165 mm chart/scale calibrated width) and SPEEDOMAX 2500 (250 mm chart/scale calibrated width) Multipoint Recorders give you a unique combination of microprocessor-based recording and alarming capabilities. For thermocouples and EMF inputs, capacity of the 1650 is 15 points; the 2500, 30 points. The 2500 can also accommodate up to 20 RTD's in addition to its TC and EMF capability. With optional alarming, the 1650 can actuate two relays; the 2500, up to 12. Other features of both models include serial communications for computer interface; simple English prompts on calculator-type keyboard to configure ranges and alarms; highly versatile capabilities for 4 alarm-levels per point; large LED displays of point number and measured value; choice of programmable chart speeds from 1″ to 240 ″/hour; and many more features.

For more information See L&N Publication C0.7111-DS

SPEEDOMAX® 165/250 1- & 2-Pen Recorders



A large number of outstanding features are built into our efficient SPEEDOMAX 1- & 2-Pen Strip-Chart Recorders: choice of wide-chart (250 mm calibrated width) or intermediate size (165 mm calibrated width); up to three ranges on "Red" pen, one range on "Blue", includes electrolytic conductivity, pH and ORP ranges. Separate chart motors allow wide choice of chart speeds—up to five on SPEEDOMAX 250, three on 165. Up to eight alarms per recorder, used in any combination for either pen.

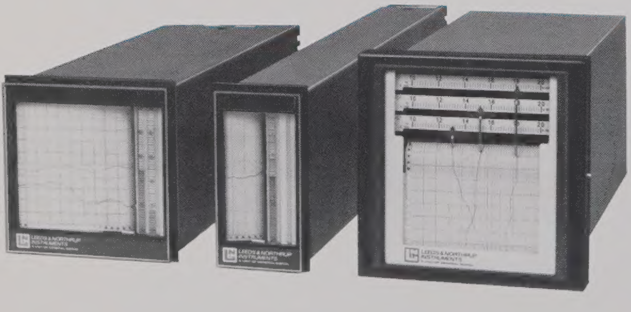
For more information See L&N Publication C0.7003-DS

PC-8500 Computer Interface Software for SPEEDOMAX® 1650/2500 Recorders & IBM PC

To improve your data management, our PC-8500 takes advantage of the Serial Communications Options in our SPEEDOMAX 1650/2500 Recorders and ELECTROMAX V^{PLUS} Controllers plus the power of the IBM personal computer. This "package" centralizes printout or computer disk storage of process variables and controller setpoints for documenting process performance. As a result, it speeds up the analysis of more accurate and timely reports and facilitates your process optimization.

For more information See L&N Publication C0.7120-TP

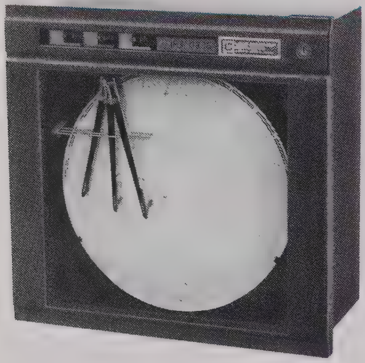
SPEEDOMAX® 100-Series 1-, 2- & 3-Pen, Miniature Strip-Chart Recorders



Wherever you need reliable recording, and space is at a premium, our SPEEDOMAX 100's are the answer. Offering most of the same features found in larger instruments, they produce easy-to-read displays, either vertically or horizontally, on 100 mm (3 15⁄16″) calibrated-width chart paper. Panel-space required for vertical-scale models is 3″ × 6″ (78 mm × 150 mm) for the wide case; horizontal-scale models is 7″ × 7″ (178 mm × 178 mm). All models accept direct inputs such as temperature, volts, millivolts, current and conductivity; indirect from transducers for pressure, flow, pH, ORP, %O_2, velocity, etc. Two optional alarms per channel. Wide choice of measuring circuits, charts and chart speeds.

For more information See L&N Publication C0.6216-DS

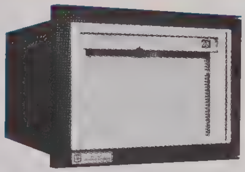
LN200-Series 1-, 2- & 3-Pen Round-Chart Recorders



Our very versatile LN200-Series Recorders are engineered for greater accuracy, improved reliability and reduced servicing. They employ a microprocessor to give you push-button control of input ranging, linearization, pen drive, pen lift, LCD display, alarms and control output. (Range cards, ranging components and slidewire have been eliminated). Highly accurate stepping motors enhance reliability and resolution. Available with up to two set points and two relays per channel for alarm or on/off control. Up to three disposable fiber-tip pens with optional ranged input or 3-position event pen as 3rd channel. Red and green LEDs indicate alarm state. Flow models totalize flow for recording and retransmission.

For more information
See L&N Publication C0.6401-DS

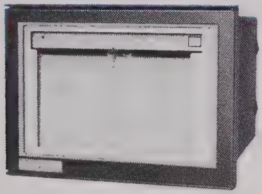
SPEEDOMAX® Turbine Supervisory (TSI) Recorder



In use since the early development of the stream turbine, L&N TSI Recorders have provided dependable and economical monitoring, recording and alarming of turbine variables such as vibration, expansion, pressure, flow, temperature, eccentricity, speed and valve position. Multi-range charts and scales, multipoint capacity (up to 30), versatile configuration aids and rugged construction give you outstanding value.

For more information Contact L&N Sales Office or representative.

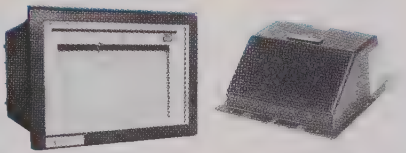
SPEEDOMAX® 165/250-Series Frequency Recorders



Our single- and dual-range frequency recorders accurately measure and record 60 Hz or 50 Hz power line frequency over spans of 1 Hz and 10 Hz. The single-range instrument monitors 55 to 65 or 45 to 55 Hz. The dual-range covers 55 to 65 and 59.5 to 60.5 Hz spans, or 45 to 55 and 49.5 to 50.5 spans. Automatic switchover to wide range. Optional automatic switchover to faster chart speed.

For more information
See L&N Publication C6.3221-DS

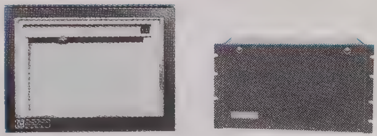
10415 Generator Field-Winding Temperature Measurement Package



To safeguard generating equipment from overheat damage, our 10415 GFWT Instrument Package continuously monitors the temperature of a generator's rotating field winding and instantly detects any abnormal heat rise. It consists of voltage and shunt current amplifiers and a ratio card mounted in a protective housing. Uses any SPEEDOMAX Recorder.

For more information
See L&N Publication C1.1301-DS

SPEEDOMAX 250-Series 100-Point Recorders



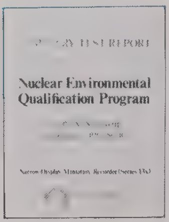
Our 250-Series 100-Point Recorders will accurately scan from 45 to 100 inputs at 1 second per point. Additionally, up to eight alarms are available for alarming on a per-group basis (one relay for each 15 points). Equipment consists of a SPEEDOMAX 250 Multipoint Recorder with integral programming panel, input relay rack and interconnecting cable.

For more information
See L&N Publication C1.1223-DS

SPEEDOMAX® Environmentally & Seismically Tested Recorders

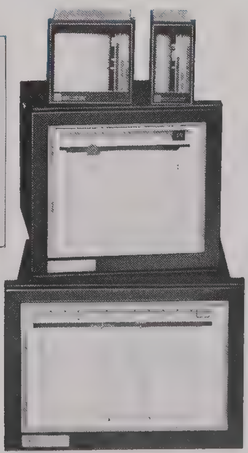
Where recorders are required by facilities licensed to operate by the U.S. Nuclear Regulatory Commission, SPEEDOMAX 100, 165 and 250 Recorders equivalent in design to units tested per the procedures of IEEE 323-1974 and 344-1975 are available. Documentation supplied with each recorder includes a Summary Test Report, operating instructions, a manual covering maintenance requirements for the 11-year qualified life (@ 40 C temperature) for which the units were tested, and Certificates of Conformance and Performance. Optionally, a full Test Report may by purchased.

For more information Contact L&N Sales Office or representative.

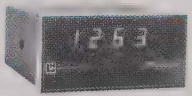


TEST REPORT

Nuclear Environmental Qualification Program



NUMATRON™ 930-Series Digital Indicators

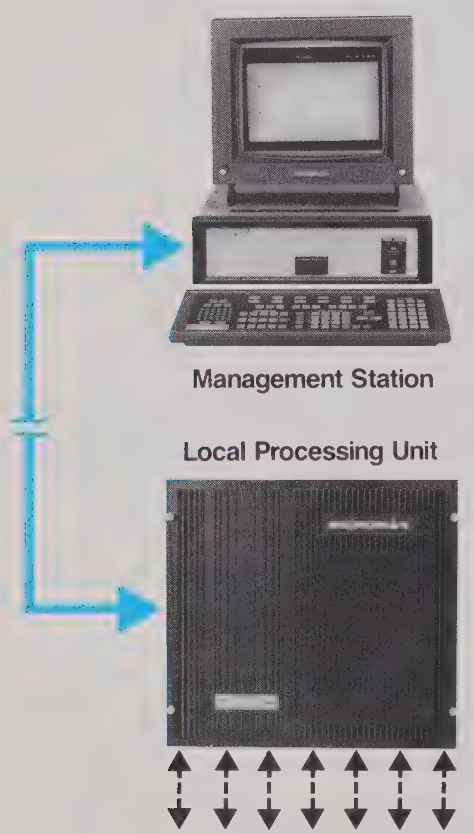


Our 930-Series Indicators are extremely reliable, rugged instruments that measure temperature, pressure, level, voltage, etc. with laboratory accuracy. Simply change plug-in modules in basic unit for any one of 19 functions to measure TC's RTD's, EMF transmitters μV or V. Features include choice of 1° or 0.1° resolution, 16 mm LED readout switchable between °F and C, digital linearization, A-to-D conversion, auto-zero stabilization, and more.

For more information
See L&N Publication F1.1225-DS

MICROMAX Data Management Center for Data Acquisition

(With Process-Control Potential)



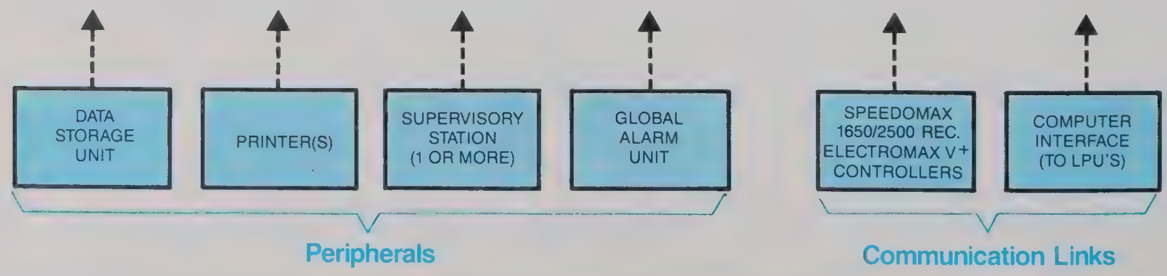
MICROMAX consists of two basic components: a Local Processing Unit (LPU) located right at the process and a Management Station (top) located at a supervisory location up to 1000 feet away. A variety of peripherals and communication links for enhancement or future expansion are shown below.

- **High-speed data gathering: 1050 points scanned within ¾ second.**
- **Management reports with no need for a computer (although computer interface available.)**
- **Superior operator interface via 16-color high resolution (640 x 480 pixels) CRT and dedicated keyboard keys.**
- **Auxiliary supervisory stations available to provide additional "windows" to process.**
- **Reports can be user-configured or pre-formatted.**
- **Accepts variety of direct inputs: TCs, RTDs, milliamps, volts, millivolts, pulse, discrete (ac/dc).**
- **Calculation capability: averaging, group averaging, math, input selects, etc. (Used in reports, trends, etc.)**
- **Alarming on any point or calculated value; high, low, rate of change, deviation.**
- **Field-mounted LPU (input processing) in NEMA 4 case; accepts up to #14 AWG wiring; reduces installation costs.**
- **Large capacity data storage unit: 45 MByte hard disk, 60 MByte streaming tape; data compression routines.**
- **Interface to existing SPEEDOMAX 1650/2500 Multipoint Recorders and ELECTROMAX V+ Controllers.**
- **Local indication/alarm acknowledge with Local Station**

. . .and more!

A MICROMAX Process Management Center (PMC) outperforms strip-chart recorders tracking as few as 75 points, and costs little more than ordinary data loggers. But there's really no comparison when it comes to its total capabilities. For example, the display is a 16-color CRT for showing a variety of graphic presentations (including various strip-chart formats). Management reports can be displayed in either standard or user-configured formats. An extensive library of algorithms for computations are provided, including averaging, group averaging, math functions, etc. Inputs of different types—millivolts, volts, milliamps, discrete signals—representing process measurements—temperatures, pressures, flows—are *directly* accepted by the PMC. All points or calculated values can be scanned for alarms and a Global Alarm Unit can provide control room annunciation. Data can be archived in real-time or in compressed form using replaceable streaming tape cartridges. And there's much more! The added value received from a MICROMAX PMC makes it far more cost-effective for data acquisition than any competitive approach.

For more information See L&N Publication G0.0001-DB. For information on Boiler Water Chemistry Management See L&N Publication G0.2000-BR.


DATA STORAGE UNIT
PRINTER(S)
SUPERVISORY STATION (1 OR MORE)
GLOBAL ALARM UNIT
SPEEDOMAX 1650/2500 REC. ELECTROMAX V+ CONTROLLERS
COMPUTER INTERFACE (TO LPU'S)
Peripherals
Communication Links

MICROMAX®
Process Management Center for Centralized Process Control
(With Integral Data Acquisition)

- Distributed intelligence to plant floor locations for on-site computations and immediate control updates.
- Wide range of analog inputs, control outputs, and discrete I/O types.
- Integrates up to 64 control loops with logic control.
- Parallel I/O processing permits all system points to be scanned in 0.25 to 0.75 seconds. Logic I/O is processed in 100 ms.
- Simplified configuration methods include unique graphic control programming and ladder logic.
- Incorporates centralized and local operator interfaces.
- Extensive alarm monitoring, reporting, and archiving capability.
- Setpoint ramp/soak program execution at field sites.
- Batch recipe storage and downloading.
- Flexible system of data storage and retrieval with compressed data formats available.
- High resolution trend displays of current and historical values.
- Both standard and user-formatted reports.
- Communication interfaces allow integration into overall plant operations.

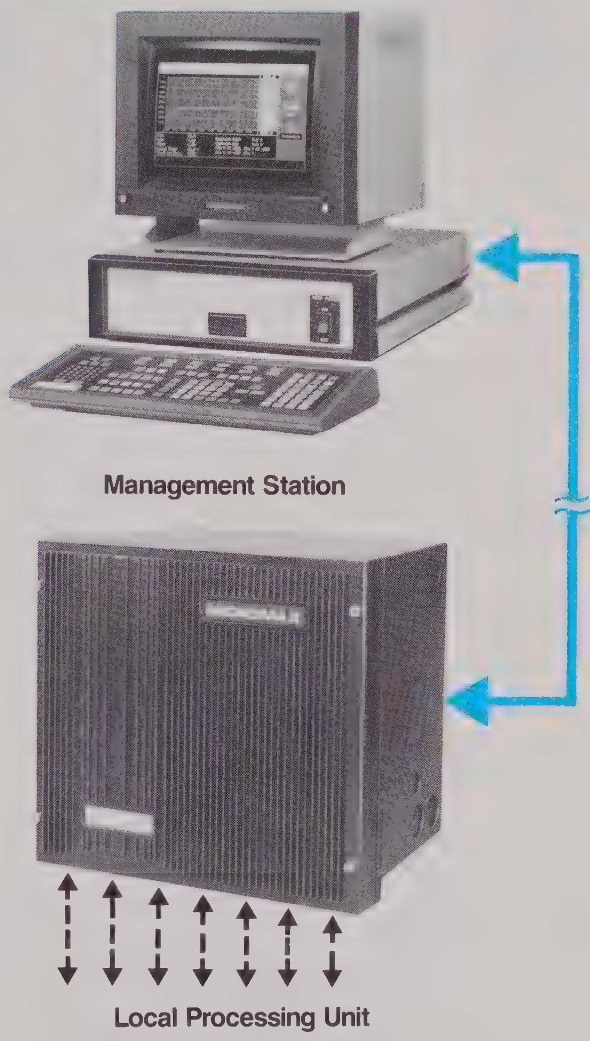
A totally new concept in process management, the MICROMAX Process Management Center (PMC) is unlike conventional control systems that require dozens of individual pieces of hardware. . . separate interfaces . . . different vendors . . . multiple sets of spare parts, maintenance techniques and individual operator training for each.

The MICROMAX Process Management Center eliminates all the *compromises* that had to be accepted when installing a system of "task specific" equipment such as PLC's, loop controllers, recorders, data loggers, etc.

The MICROMAX Approach

MICROMAX integrates loop control, logic control and data acquisition into a single compact facility. MICROMAX is powerful, economical and exceptionally easy to install and operate. Regardless of your application—whether batch or continuous process—MICROMAX will serve as an efficient, inexpensive, process-management center. Employing distributed architecture, it allows for low-cost incremental expansion, and remains cost-effective even when your initial requirements are small.

For more information See L&N Publication G0.0001-DB



*MICROMAX Process Management Center has two basic components: **Management Station** with 16-color CRT display, custom keyboard and Electronics Unit; accesses data from the LPU, allows on-line operation of all data management functions, alarm reporting, trend displays, event status, data reporting, etc.; can be located up to 1000 feet away. **Field Station** consisting of a Local Processing Unit (LPU) in a rugged NEMA-4 cabinet and its associated hardware; provides intelligence local to the process. Expandable up to 16 Field Stations per Management Station.*

MICROMAX
P1 S1 RAMP-100.0/H SPT 25.0 02-00-00S

One of a group of optional accessories for the MICROMAX PMC is this Local Station. It allows local supervision of process monitoring, auto/manual operation, alarm acknowledgement and batch/recipe downloading right at the process.

MAX 1 Fiber Optic Highway Base Distributed Data Acquisitio

Total Process Control

- **Powerful control blocks** library of 40 primary control algorithms plus specific-process algorithms.
- **High-level EXCEL programming** language for custom operator interaction, serial interfacing, optimum logic execution.
- **In-depth batch control capability** with sequence algorithms, setpoint programming, batch reporting, more.
- **Standard or custom linearization** of process variables.
- **Dependable performance** due to advanced diagnostics and strategic multi-level redundancies.
- **Analog input/output** mA and volts, current-adjusting and position-adjusting outputs.
- **Digital input/output** isolated AC, DC

Comprehensive Data Acquisition

- **Extensive data point calculations** for more and better views of all important process conditions.
- **Powerful distributed trending capability** for truly meaningful information display—up to 500 analog, 500 digital values at each Operator Station.
- **Custom reports** generated via Management Information System (MIS).
- **Logs available** on time or demand basis.
- **Permanent archiving of data** to removable media.
- **Extensive alarming capability** plus high-resolution recording of plant upset.
- **Accepts data from a variety of sources** high-level inputs, serial multiplexed inputs, parallel digital inputs/outputs.

Comprehensive data acquisition and complete process control on a plant-wide basis can be quickly and effectively implemented with Leeds & Northrup's MAX 1 Distributed Process Control System.

Using new-generation tabletop Operator Stations and Controller Families operating along an advanced fiber optic data highway system, cost-efficient acquisition of process data and control of process operations is readily achieved.

No computer is needed to drive the MAX 1 System (although "guest" host computers can be easily interfaced at any point along the optical highways), yet it will provide centralized data gathering and master control of more than 1600 loops with security at all levels. A MAX 1 System costs less to install, operate and maintain than systems which do not approach its capability.

Performance is remarkable. The fiber optic highway carries data at distances up to 20,000 feet at a rate of 500 kbaud. This data highway is immune to ground loops, electro-magnetic and radio interferences, hazardous atmospheres, moisture and corrosion. Because of these qualities as well as the redundancy provided by the dual data highway, there is a rapid exchange of process data with maximum security at all times and under any conditions.

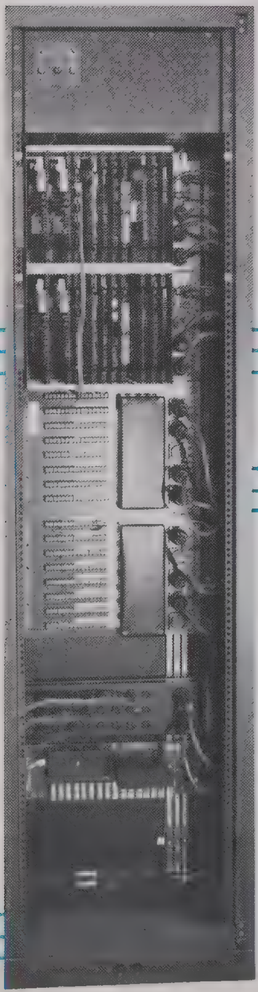
Find out how you can achieve better process performance, using fewer pieces of hardware, in an easily expandable modular system configuration which grows as your requirements grow. Investigate the unique MAX 1 Distributed Control System.

For more information See L&N Publication CO.0702-BR

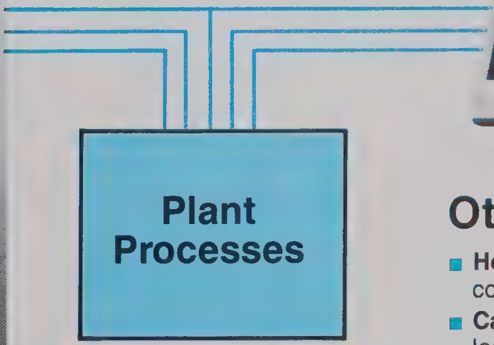
and Control System

Fiber Optic Communications

- **High-speed transmission** of data at a rate of 500k baud is attained via an advanced fiber optic highway.
- **Communications are maintained** throughout plant at distances up to 20,000 feet.
- **Completely redundant dual fiber optic cables** are both active at all times to reassure uninterrupted data transmission.
- **Transmission is unaffected by noise** EMI, RFI, crosstalk.
- **Fiber optics are immune** to ground loops, safe to operate in hazardous environments.
- **Cable is impervious to moisture,** won't corrode.
- **Cabling is supplied** factory-terminated, with simple field connections.



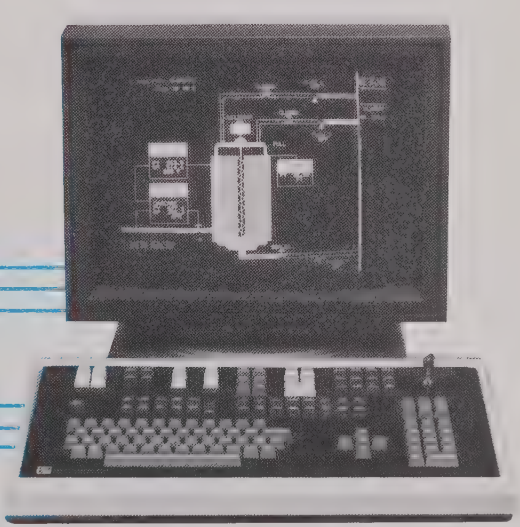
552 Controller



Advanced Operator Station

Many modular options offered—

- **Trend package** provides multi-color display of current and historical process data.
- **Management Information System** develops custom logs and reports, performs other valuable functions.
- **Second screen** available for economical additional information display.
- **Up to four printers** can be incorporated.
- **Dedicated alarm contacts** available wherever the application warrants it.



582 Operator Station

Other Added Attractions

- **Host computer support** provided for IBM PC-AT computers and VAX family of computers.
- **Can interface** with programmable controllers, single-loop controllers, user-programmed devices with RS232 communications ports.
- **System security assured** through
  - —dual redundant highway
  - —one-to-one control backup
  - —independent Operator Stations
  - —avoidance of a traffic director
  - —extensive system diagnostics.

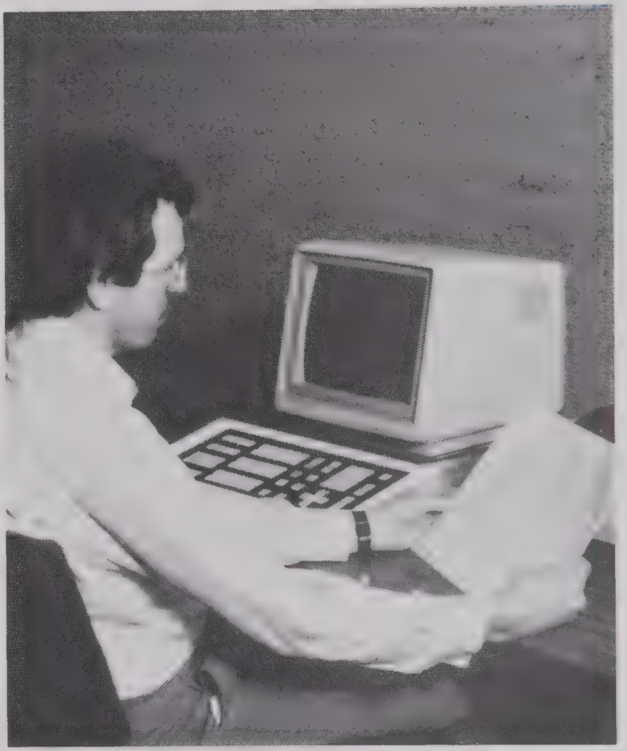
LN700 Distributed SCADA/EMS System

Leeds & Northrup's LN 700 Distributed SCADA and Energy Management System embodies a unique modular approach which makes it equally adaptable to both small scale SCADA systems and large energy control systems. Or to small systems in the process of growing bigger. The LN 700 concept of coupling a powerful microcomputer-based master station with the versatile L&N CONITEL series of remote terminal units in a customized distributed architecture permits tailoring the control system to fit exact utility needs, not only for the present but for the future as well.

The only distributed SCADA/AGC control system available today, LN 700 enables a utility to quickly place on line equipment to perform the tasks at hand while protecting against the possibility of future obsolescence resulting from expansion. The LN 700 System can be effectively applied to tiny SCADA networks monitoring as few as 500 data points from four or five remote terminal units, as well as to huge installations having hundreds of remotes totalling 50,000 or more data points. The LN 700 Distributed System adjusts to fit the information needs for both the current situation and for possible expansion at a later date. The distributed architecture provides the flexibility needed to cope with changing parameters and added requirements.

Built to Perform

An LN 700 Distributed System employs high-speed 32-bit multiprocessors for unlimited processing power, plus a technically advanced multiprocessing bus and internationally specified Eurocard packaging. The System is built to provide the dependable performance for which Leeds & Northrup is noted. Yet, because the modular hardware is common to all stations and each system is developed in increments, the software is simple and straightforward. A computer-assisted configuration process, completely human-engineered, assures that all programming and configuring of the LN 700 is easily understood and executed. By definition, the LN 700 System is the state-of-the-art approach to achieving superior distribution monitoring, automatic generation control, network modeling and load management.



With early delivery of only one Operator Station and Communication Station, you can dramatically shorten the entire system installation time by building the database and displays months before installation of the hardware.

Eight Great Advantages

1 Quick Return On Investment
The distributed architecture of the LN 700 System allows factory configuration to your specific application before shipment. You uncrate it, connect it, and go commercial almost immediately — far sooner than with any conventional dual-computer system.

2 Superior Performance
Measured against any accepted criteria, the LN 700 System outperforms the competition. Like handling up to 50,000 database points, responding to an operator entry with 0.5 seconds, and offering a system availability greater than 99%.

3 Ready System Expandability
Over time, you can grow from a small LN 700 System with a single operator station and five or six remotes of a hundred points each into one with multiple operator stations and hundreds of remotes by simply making incremental modular additions to your existing equipment.

4 Add-on Functional Capability
Modules can be added to provide generation control and more application processing whenever desired.

5 Maximum Reliability
All system hardware is distributed along a dual-redundant, high-speed electrical highway for secure data transmission — there's no critical dependency on a single dominant CPU.

6 Operator Friendly Design
A clean, logically organized operator panel and easily understood dynamic video screens facilitate timely operator response to changing system conditions.

7 Lower Operating Costs
The LN 700 System's distributed processing concept bypasses the requirement for an expensive central host computer.

8 Longer Equipment Life
Very Large Scale Integration (VLSI) circuitry operates on low input power, minimizing the effects of temperature on equipment life.

For more information See L&N Publication E7.6112-SBR.

LN700 SCADA/EMS Benefits

Benefits to Management

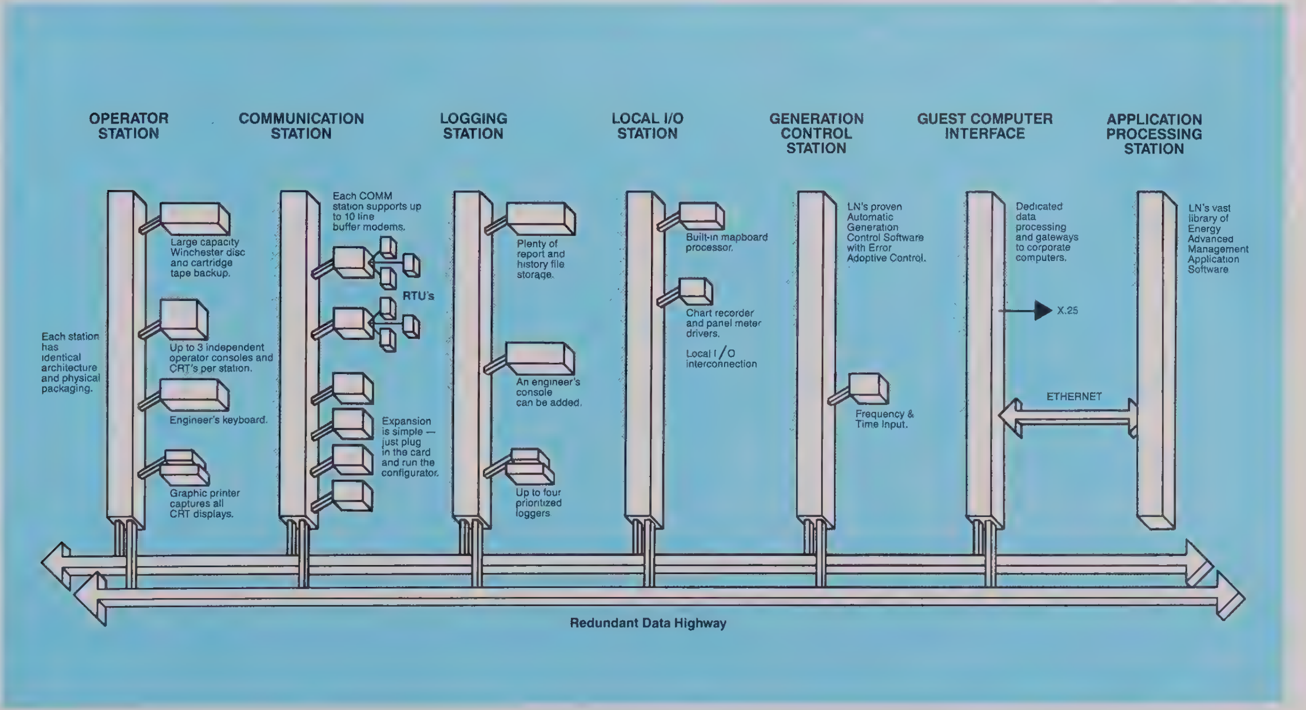
- **Cost effective** you pay only for the capability you need now.
- **Modular distributed architecture** allows incremental additions when required.
- **Expansion flexibility** removes threat of obsolescence.
- **Can be put into rate base quicker** than other systems for improved R.O.I.
- **Permits quicker access** into data base.
- **Exceptionally adaptable** to restructuring of data for management reports.
- **Built and backed by an experienced, reputable supplier.**

Benefits to Engineering

- **Unexcelled performance** due to superior processing power.
- **Assured reliability** through distributed control with multiple microprocessors and failsafe architecture.
- **Simple, easy configuration** can even be done in advance of delivery.
- **Software flexibility** resulting from user-defined calculation routines.
- **Fast buildup of displays** using an extensive library of shapes.
- **Automatic restarting** and self-diagnostic routines.
- **Minimum installation costs and space requirements** (compared with dual redundant central CPU systems).

Benefits to Operations

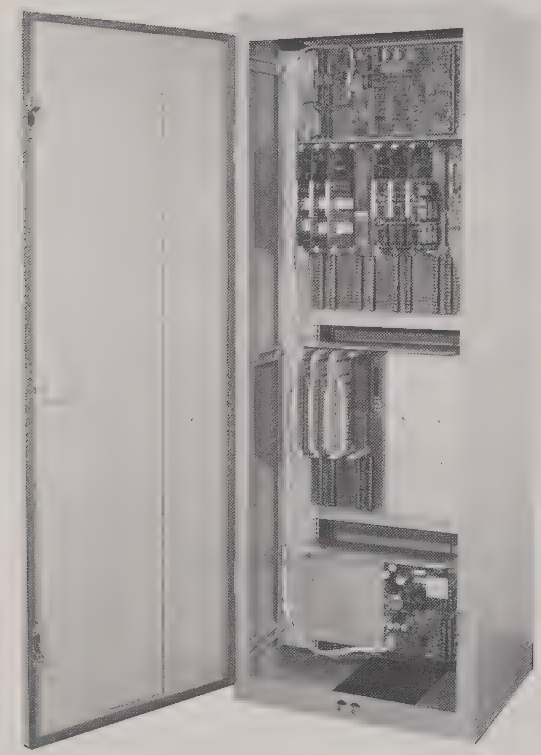
- **Logical and efficient arrangement of pushbuttons** provides a user-friendly operator interface.
- **System stability** is enhanced through fast CRT updating which allows prompt operator intervention in varying system conditions.
- **Regional separation of displays** provides an uncluttered view, enabling the operator to quickly check system status.
- **Immediate interpretation of conditions** is made possible through snapshots and trend views which are instantly available on command.
- **Video screen panning and windowing capability** permits both a fast access to and a full examination of any point in the system.
- **Upsets are quickly detected** through prioritized alarms.


OPERATOR STATION
COMMUNICATION STATION
LOGGING STATION
LOCAL I/O STATION
GENERATION CONTROL STATION
GUEST COMPUTER INTERFACE
APPLICATION PROCESSING STATION
Each station has identical architecture and physical packaging.
Large capacity Winchester disc and cartridge tape backup.
Up to 3 independent operator consoles and CRT's per station.
Engineer's keyboard.
Graphic printer captures all CRT displays.
Each COMM station supports up to 10 line buffer modems.
RTU's
Expansion is simple — just plug in the card and run the configurator.
Plenty of report and history file storage.
An engineer's console can be added.
Up to four prioritized loggers
Built-in mapboard processor.
Chart recorder and panel meter drivers.
Local I/O interconnection
LN's proven Automatic Generation Control Software with Error Adoptive Control.
Frequency & Time Input.
Dedicated data processing and gateways to corporate computers.
X.25
ETHERNET
LN's vast library of Energy Advanced Management Application Software
Redundant Data Highway

Distributed SCADA System

C-300 Remote Terminal Unit (RTU)

Advanced Technology at reasonable cost.

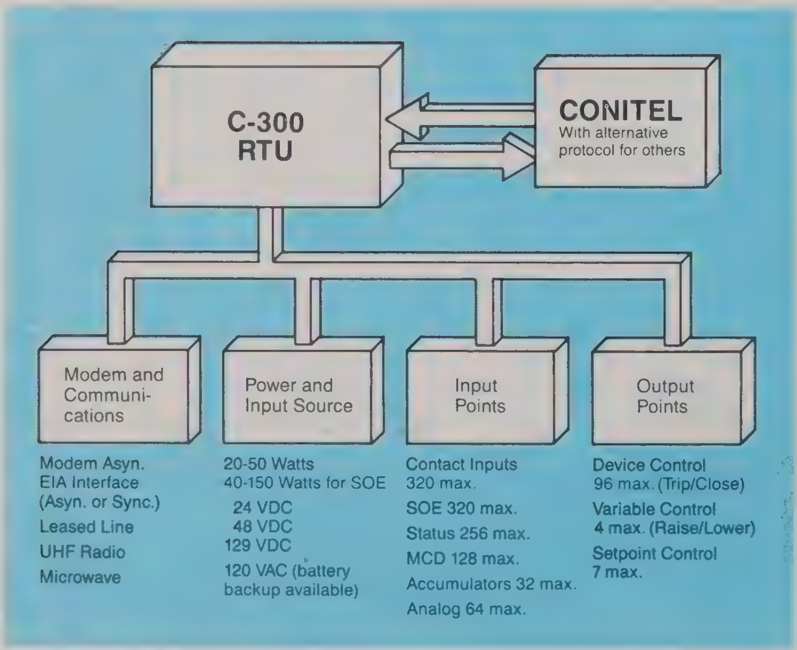


The LN C-300 RTU embodies advanced technology in an economical package. Three microcomputers incorporated in the remote handle all the required functions. One microcomputer interfaces to the master station communications, a second microcomputer controls all contact-type inputs, and a third microcomputer controls all analog inputs and control outputs. There is adequate PROM and RAM memory to execute all the functional tasks of a remote, as well as the start-up and on-line diagnostics.

Design Advantages

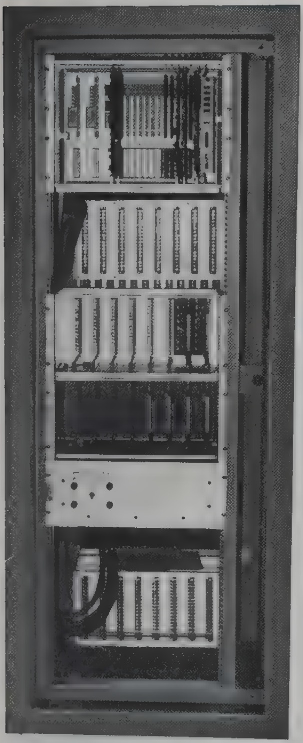
- **Low Power Requirements** each remote needs only 50 watts of power for operation. (An additional 100 watts are required for SOE)
- **Versatile Communications Links** features all standard interfaces to microwave, lease lines, and radio.
- **Comprehensive Output Capability** a variety of outputs are available to fit the requirement, including analog and digital setpoints, medium and heavy duty Trip/Close outputs, and generator Raise/Lower signals.
- **Flexible Digital Input Capability** Identical digital point cards handle multiple functions according to data base descriptions.
- **Non-Volatile Memory** data from remotes becomes instantly available following a power interruption.
- **Continuous Status Indication** LEDs show status of input power, output voltages and communication parameters.
- **Information Easily Updated** employs a user-friendly data base compiler.
- **High Speed Updating** rapid and continuous updating of data regardless of the level of activity at the remote.
- **Sequence of Events Notification** 1 ms resolution on any contact point is available for local printout or transmission to the master station.
- **Automatic ADC Calibration** drift correction and automatic recalibration are standard features within the remote.
- **Double System Security Safeguards** two security measures are taken to prevent operating errors; Trip/Close control outputs use a "check before operate" safeguard as well as "only the right relay selected."
- **IEEE Surge Protection** all I/O points, communications, and power source ports are surge protected per IEEE standards.
- **Self-Diagnostic Circuitry** Start-up and on-line diagnostices constantly monitor the remote's operational capability.
- **Adaptable Installation** C-300 Remote Terminal Units can be mounted in free standing NEMA 1 cabinets, 76″ or 90″ high, or NEMA 12 cabinets, 90″ high, or in NEMA 4 wall cabinets, 36″ high.

For more information See L&N Publication E7.6110.SDS


C-300 RTU
CONITEL
With alternative protocol for others
Modem and Communi-cations
Power and Input Source
Input Points
Output Points
Modem Asyn.
EIA Interface (Asyn. or Sync.)
Leased Line
UHF Radio
Microwave
20-50 Watts
40-150 Watts for SOE
24 VDC
48 VDC
129 VDC
120 VAC (battery backup available)
Contact Inputs 320 max.
SOE 320 max.
Status 256 max.
MCD 128 max.
Accumulators 32 max.
Analog 64 max.
Device Control 96 max. (Trip/Close)
Variable Control 4 max. (Raise/Lower)
Setpoint Control 7 max.

C-3000 Remote Terminal Unit (RTU)

"Genius" Remote with Super Versatility



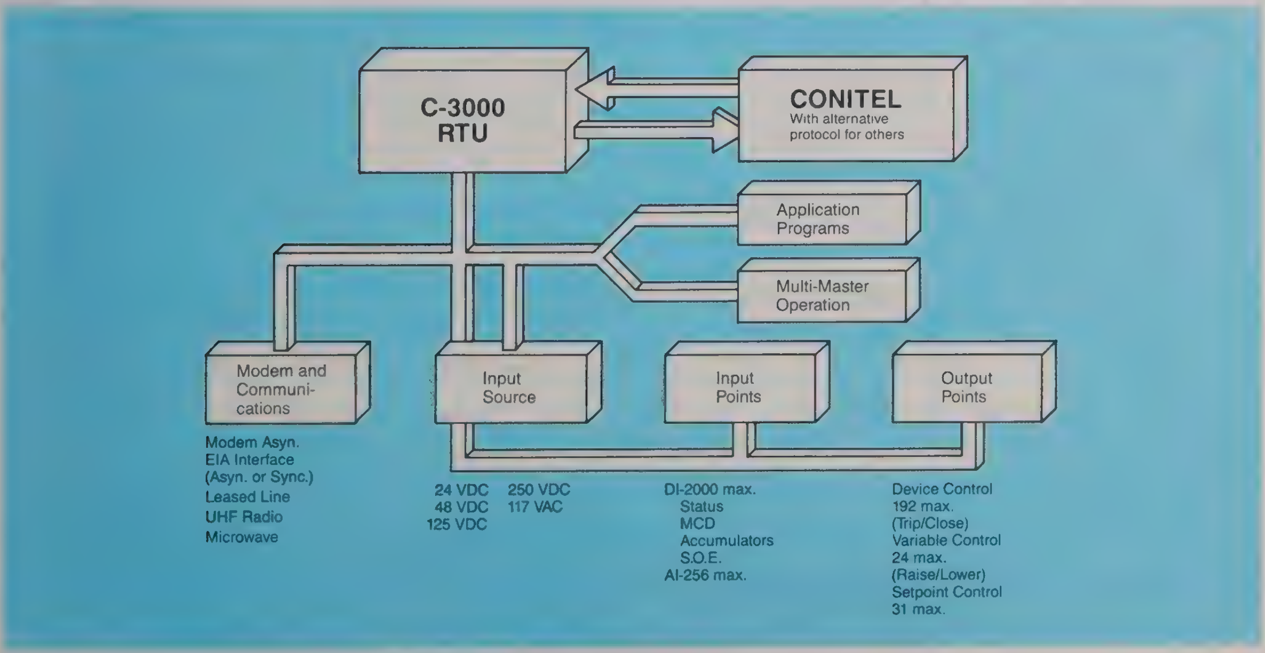
The versatile C-3000 remote offers the capability to perform not only the traditional SCADA routines but many additional functions as well. Included among its capabilities are MVA calculations, automatic device reclosure, automatic breaker control synchronization, and transformer tap changing all implemented using a high level language. It is also able to perform functions independently without instructions from the master station, such as polling by exception, limit checking, and on-line error checking.

Since the C-3000 remote is multi-microprocessor-based and can emulate multiple protocols in addition to CONITEL, it can talk to multiple masters. In addition to pulse duration operation, device control and generator control, the C-3000 can monitor sequences of events, execute accumulator and flow calculations, store real-time data on a historical basis, and accept downline loaded values of data. It also performs on-line and start-up diagnostics.

Design Advantages

- **Quality Resolution** 1 ms at remote.
- **Versatile Message Formats** status words and polling words included.
- **Easily Expanded Memory** more RAM and PROM can be readily added to the multibus card cage.
- **Customer Programmable** high level language available.
- **More Calculation Power** arithmetic processing unit available.
- **Large I/O Capacity** up to 2000 digital inputs and 256 analog inputs, plus 192 control points.
- **IEEE Surge Protection** all I/O, including communications and power supply, are surge protected per IEEE standards.
- **Rapid Communications** up to 2400 baud in either synchronous or asynchronous mode.
- **Easy to Configure** employs a user-friendly data base compiler.
- **Input Flexibility** achieved via the data base compiler.

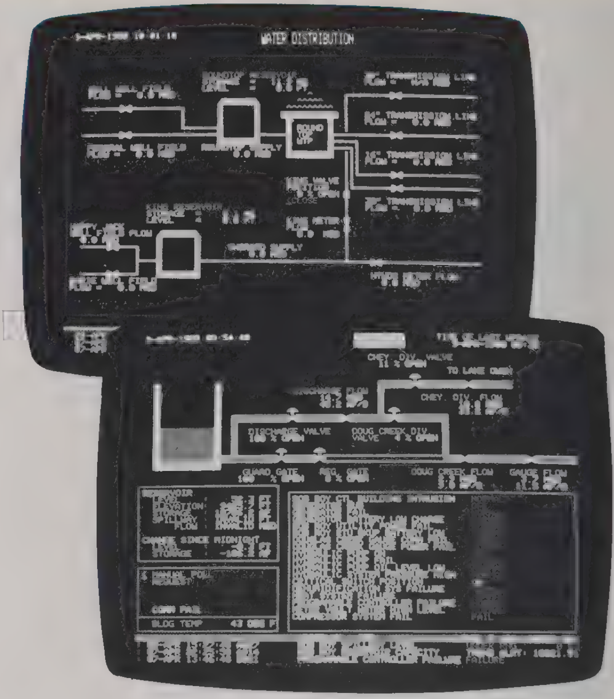
For more information See L&N Publication E7.6109-SDS


C-3000 RTU
CONITEL
With alternative protocol for others
Application Programs
Multi-Master Operation
Modem and Communi-cations
Input Source
Input Points
Output Points
Modem Asyn.
EIA Interface
(Asyn. or Sync.)
Leased Line
UHF Radio
Microwave
24 VDC
48 VDC
125 VDC
250 VDC
117 VAC
DI-2000 max.
Status
MCD
Accumulators
S.O.E.
AI-256 max.
Device Control
192 max.
(Trip/Close)
Variable Control
24 max.
(Raise/Lower)
Setpoint Control
31 max.

BIF ACCUTEL™

L&N's Computer-Based Supervisory Control for water/sewage systems & oil/gas pipelines

- **Assured reliability with redundant CPU capability.**
- **Easy-to-use menu-driven software.**
- **Fast display building using library of symbols.**
- **Historical data—statistical & trend—maintained for all points**
- **Automatic starting with self-diagnostics.**
- **Software flexibility for unlimited growth.**



Typical Graphic Displays

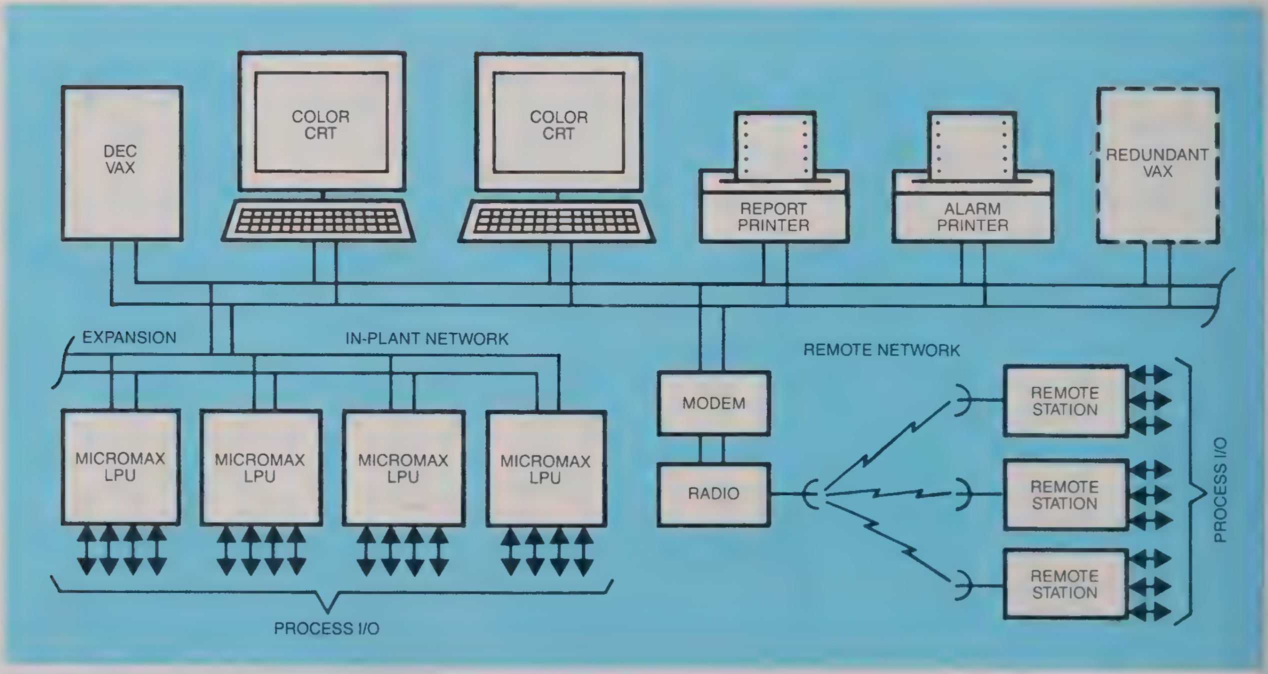
Leeds & Northrup's BIF line of products represents over 150 years of experience in water and sewage measurement and control. We've combined this experience with modern computer technology to produce our innovative ACCUTEL System.

ACCUTEL meets uniquely different customer requirements by using a building block selection of computer hardware and software, signal interfacing, data display and control equipment.

The **ACCUTEL** System employs the ATTOBIF™ software package which operates on any Digital Equipment Corporation's (DEC) VAX family of computers. For in-plant loop and logic control, ACCUTEL can interface, via a high-speed data network, with L&N's MICROMAX Local Processing Units. For remote stations, BIF BRITE™ Telemetry equipment provides reliable security and process interface over any voice-grade channel such as radio, microwave or telephone circuits.

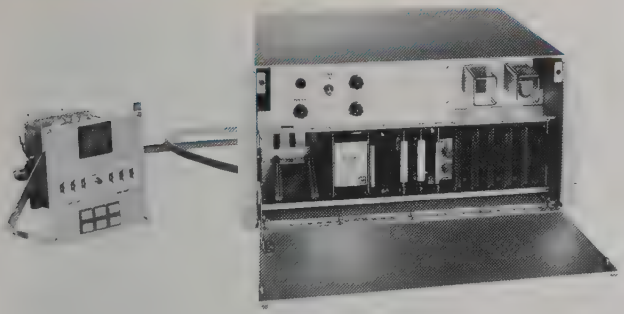
With the **ACCUTEL SCADA** System and **ATTOBIF** Software, the size and configuration of your in-plant and remote system is virtually unlimited. And you have complete freedom to configure and expand the system in a user-friendly environment for all your local and remote data acquisition, loop and logic control requirements.

For more information See L&N Publication 266.201-2


DEC VAX
COLOR CRT
COLOR CRT
REPORT PRINTER
ALARM PRINTER
REDUNDANT VAX
EXPANSION
IN-PLANT NETWORK
REMOTE NETWORK
MODEM
RADIO
MICROMAX LPU
MICROMAX LPU
MICROMAX LPU
MICROMAX LPU
REMOTE STATION
REMOTE STATION
REMOTE STATION
PROCESS I/O
PROCESS I/O

Typical System Configuration

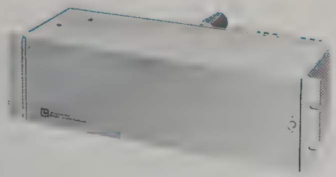
Dispatch Unit Controller



The L&N 11401 Dispatch Unit Controller regulates the output of a generating unit at a power generating station in response to raise and lower control pulses transmitted from the Load Dispatch Office or Energy Control Center. Interface options to various boiler and governor controls are available. Through the governor motor (or other governor interface devices), the Dispatch Unit Controller adjusts the output of the generator until it is at the desired level. One option that is available is to operate the controller through a supervisory remote terminal unit. Because the operators of the generating station have the ultimate responsibility for maintaining plant safety, setters and pushbuttons provided on the control panel of the LN 11401 Controller enable the operators to override external signals should operating limitations call for their intervention.

For more information See L&N Publication E7.3163.SAB

Frequency Deviation Transducer



The LN 10981 Frequency Deviation Transducer is both a frequency standard and a digital deviation transducer which can provide a precise frequency deviation signal for recording and control. With an accuracy of up to ±0.0001 Hz and a stability as low as 2 parts per million, the LN 10981 Transducer can make a significant improvement in Automatic Generation Control systems. The LN 10981 Transducer can be supplied in several versions: one for wide range applications (±10 Hz), two others for wide and narrow range applications. Each has a different degree of resolution to match the application. All three versions can be equipped with both digital and analog outputs for application versatility.

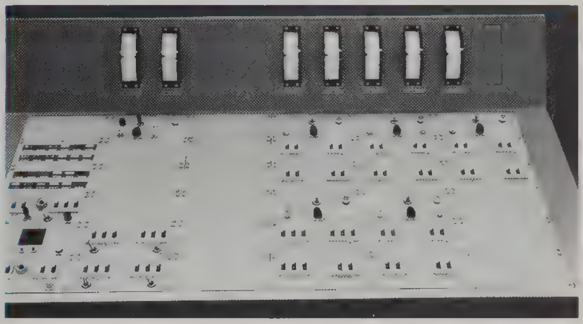
For more information See L&N Publication E7.1131-SAB

Time Deviation Transducer

The LN 10982 Time Deviation Transducer, using a companion LN 10981 Frequency Deviation Transducer, provides a precise time deviation signal which is used for Automatic Generation Control plus system time deviation monitoring. Power control systems with many interconnections can use the LN 10982 to reduce time errors and minimize inadvertent interchange power flow. With both digital and analog outputs, the transducer can be interfaced to digital computers, to analog recording and control systems, or to a local digital time display. The LN 10982-10 has a range of ±10 seconds, the LN 10982-11 has a range of ±100 seconds.

For more information See L&N Publication E7.1132-SAB

Automatic Generation Control and Dispatch System



The Leeds & Northrup SEP 22 Analog Control Systems have been developed to provide Load Frequency Control and Economic Dispatch for Electric Power Systems. The flexibility of these systems enables them to fill the requirements of three distinct applications of power system control for central dispatch operations. These are:

(a) The basic development of Area Control Error which can include the control signal: L&N SEP 22-1

(b) The allocation of the control signal based on Selective Broadcast Control: L&N SEP 22-2

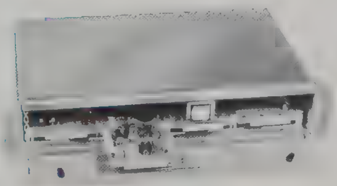
(c) A manually programmed Generation Dispatch System for economically allocating the control signal among dispatch units. L&N SEP 22-3

These systems are available for primary control or as first or second level backup control. Four modes of control are offered: Frequency, Tie Line, Tie Line Bias or Time Error Bias Control. The L&N SEP 22 Analog Control Systems adapt to the requirements of an isolated system, an interconnected industrial power system, or a larger interconnected electric utility.

For more information See L&N Publication E7.3185-SAB

L&N Analog Telemetering System

The L&N Analog Telemetering System provides fast, accurate and stable telemetering at an economical cost. Plug-in printed circuit cards are used in both the oscillator and converter to simplify maintenance and spare parts stocking (the power supply cards are identical).

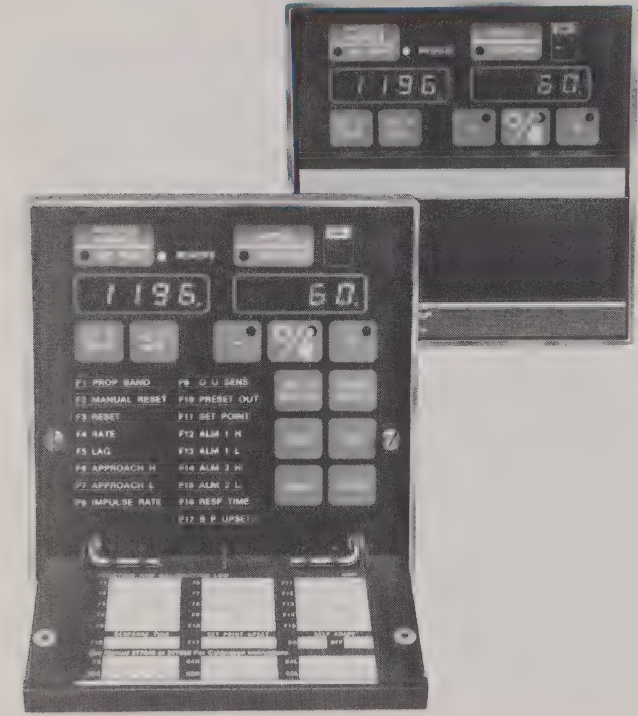


The LN 10776 Variable Frequency Oscillator accepts high-level voltage inputs from 1 to 5 volts, low-level millivolt inputs from 20 millivolts to 1 volt, and milliamp inputs. (Low-level ranges require an optional plug-in amplifier.) Output is any of the standard frequency ranges, obtained by plugging in appropriate capacitors and adjusting high and low ends of the span through "zero" and "range" trimmer potentiometers. Linearity and long-term drift characteristics are excellent

The LN 10818 Telemetering Converter accepts all commonly used input frequency ranges and generates a DC output which is a precise function of input frequency. Output cannot short circuit, may be of either polarity, and can be sent simultaneously to recorders, indicators and computers. Plug-in jumpers permit easy range and zero changes

For more information See L&N Publication E7.2114-SDS

ELECTROMAX® V^{PLUS} Single-Loop Controller

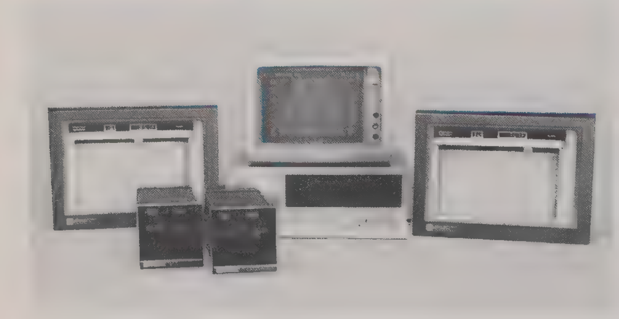


Outstanding versatility and low cost are only two of the many advantages you get with our microprocessor-based ELECTROMAX V^{PLUS} Controllers. Also included are exceptional accuracy, stability, reproducibility and reliability for every process control application. ELECTROMAX V^{PLUS} gives you a full choice of proportioning-control outputs: position-, current- and duration-adjusting types. They are available with our unique self-tuning option which automatically adjusts the PID parameters for optimum response to any deviation from set point.

The ELECTROMAX V^{PLUS} accepts *direct* millivolt, thermocouple, radiation detector, RTD (low-level) or transmitter (high-level) inputs. Thermocouple, radiation detector or RTD inputs (either low- or high-level) are linearized for direct reading in degrees F or C. The controller displays bold LED digital readouts of process variable, setpoint, deviation, control output, alarm settings and all essential controller parameters. Displays and settings are easily "called up" via dedicated touch-switches on the front panel. Other major features include set-point programming, dual inputs for ratio, summer, setpoint bias, feedforward or mass flow; dual alarms; auto/manual and remote/local set-point operation; serial communication with computer or other devices via RS422/485 Interface. ELECTROMAX V^{PLUS} *On-Off and Alarm-Limit Controllers are also available.*

For more information See L&N Publications C1.1511-DS (Proportioning Control) or C1.1512-DS (On-Off & Alarm-Limit Control).

PC-8500 Computer Interface Software for SPEEDOMAX 1650/2500 Recorders, ELECTROMAX V^{PLUS} Controllers and IBM PC



Our PC-8500 Software can be your first step toward total plant automation. Used with an IBM personal computer, it lets you operate up to 30 SPEEDOMAX Recorders or up to 60 ELECTROMAX Controllers from one centralized location. PC-8500 stores all your recorder or controller configurations and downloads for fast controller substitution or process turnaround. It also stores recipes and downloads them to controllers using your own recipe names, plus individual recorder point or controller tag names. Additionally, it generates reliable alarm recording and displays, and streamlines your data access by centralizing data acquisition and storage.

For more information See L&N Publication C0.7120-DS

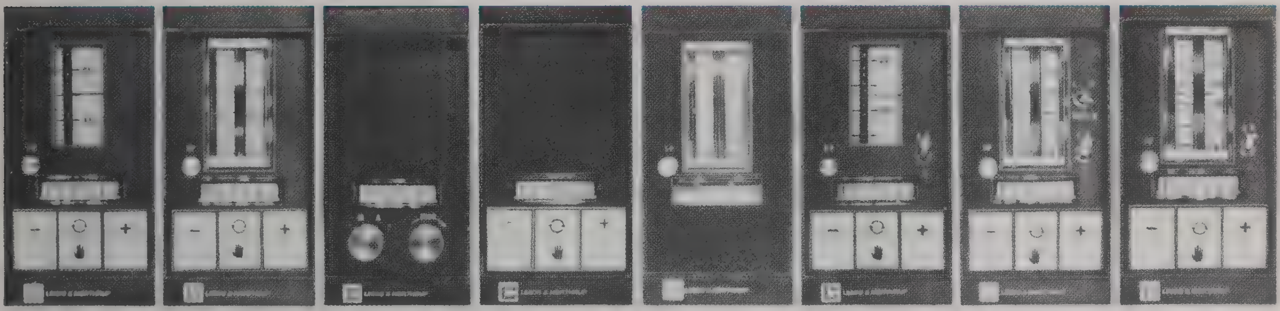
1300 Process Programmer

1300 process programmer
5
3200

This versatile microprocessor-based instrument regulates a setpoint input to a controller according to a pre-set program—a recipe of time/temperature "ramps" and "soaks" which are entered into the 1300's memory via its unique dedicated keyboard. Flashing LEDs guide the entry sequence. (Programming experience NOT required.) Plug-in Program Storage Modules allow quick copying and downloading programs in seconds. Sensor curves permanently stored in memory automatically characterize signals. Dual program capability runs two different controllers concurrently—either independent or interrelated. Choice of voltage or current output ranges permit use with most controllers.

For more information See L&N Publication F1.1415-DS

CENTRY® Process Control



Here's a comprehensive line of discrete modular-type analog instruments for reliable process control. The CENTRY line includes basic controllers, computer interface controllers, signal conditioners, computation modules, alarm units, mounting devices, terminations and other accessories. Each instrument is exceptionally compact for high-density packaging and requires minimum panel-board space. Other CENTRY advantages include application flexibility; low initial and installed costs; very easy, low-cost maintenance, . . . and more.

Controllers – Expanded- or full-scale, current- or position-output with optional auto/manual switching. Ratio Station, setpoints manually set or computer directed.

Computer-Interfaces – for DDC or Supervisory Control; computer-signal conversion, logic circuits, relays and status indication lights; automatic or manual backup.

Front-Panel Displays – CENTRY is compatible with SPEEDOMAX 100-Series Recorders; also milliammeter-type indicators and integrators.

Signal Conditioners – For back-of-panel mounting; Alarm; Multiplier/Divider; Square-Root Extractor; Isolator; Summer.

Terminations – Hard-wired or plug-in cord sets for input and output connections; Central Distribution Panel for loop interwiring.

Accessories – Intrinsic Safety Barriers and bus bars; temporary "Hold" stations; circuit/loop test set; modular mounting equipment.

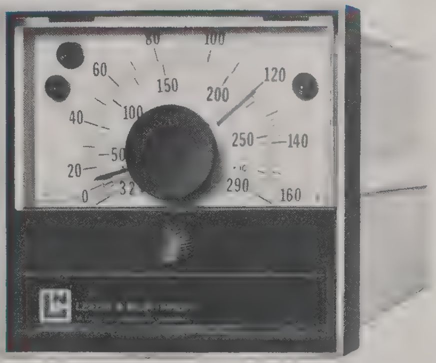
For more information Contact L&N Sales Office or Representative.

Manual Backup Control Stations

Our economical Manual Backup Stations provide essential security for any automatically controlled process. Their cost makes them practical for every application. Using an L&N Backup Station, an operator can manually regulate the control element during startup or shutdown, or quickly assume manual control if a process upset occurs. These stations also permit the primary controllers to be removed for periodic maintenance without shutting down the process. Models available for current or position output.

For more information See L&N Publication C1.1701-DS

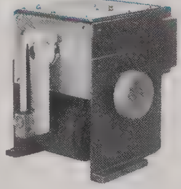
1500-Series Alarm-Limit Controllers



Our 1500-Series instruments give you good value in a simple, reliable, low-cost, high-limit temperature controller. These compact, rugged instruments provide a continuous analog indication of measured temperature from a Type J, K, R, S, or W5RE-W26RE thermocouple. A green pointer indicates temperature; the alarm limit is indicated by a red pointer manually set by a knob on the front of the case. When the alarm limit is reached, a red light on the front panel is lit and a SPDT relay (10A rating), normally energized, is tripped. UL listed; ¼-DIN size aluminum case.

For more information See L&N Publication C1.1611-DS

10260-Series Valve-Drive Motors



Our 10260 Drive Motors precisely position valves, dampers and other devices that require remote, automatic positioning. Operating from a process controller using raise/lower contacts or a 4-20 mA signal, they employ non-coasting motors and worm-gearing for fast, accurate, full-torque response to small changes, dead-stops. Self-locking and releasing, they hold last position in power loss. Permanently lubricated, maintenance-free.

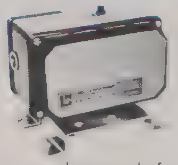
For more information
See L&N Publication C12.1121-DS

Phase-Angle-Firing SCR Power Package

Used with current-adjusting-type (C.A.T.) controllers, these devices provide stepless input of power to electric-heating processes. Both single- and three-phase units are available. "Soft-Start" feature protects power-handling elements from damage. Standard bias and gain adjustments; current-limiting available.

For more information
See L&N Publication C12.1145-DS

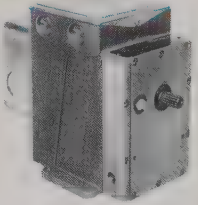
10970-Series Electro-Pneumatic Converter



Utilizing an advanced force-balance design, our 10970-E/P Converter is a highly reliable *vibration-resistant* device that converts a current input from a controller or other source to a proportional pneumatic output. Choice of full-range or field-adjustable split-range mA inputs; 3-15 or 6-30 psig output ranges, field-changeable to reverse acting.

For more information
See L&N Publication C12.1233-DS

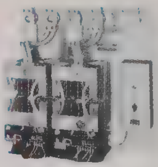
10210-Series Valve-Drive Motors



For economical positioning of small control valves where the power and speed of larger units are not needed, our 10210-Series Drive Motors provide outstanding value. They offer a wide choice of 130 or 220 lb-in. torques, 50- or 1000-ohm feedback slidewires, limit-switch combinations, plus auxiliary slidewires and switches for position control. The 10210's also provide many operating features of larger drive units.

For more information
See L&N Publication C12.1122-DS

LZF Zero-Voltage-Firing SCR Power Packages



The LZF Zero-Voltage-Firing Power Packages provide solid-state control of a-c power in electric heating processes having purely resistive loads. Direct-firing into single-phase loads or three wire, three-phase balanced loads (either delta or wye). Connected directly to the load (no transformer required). Very low RFI generation; ideal for use near computers. Typical control signal 0-5mA. Current ratings from 25 to 600A.

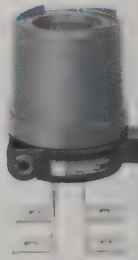
For more information Contact L&N Sales & Service Office or representative.

10973-Series Motor-to-Pneumatic Transducers

These motor-operated pressure transducers convert controller raise/lower output signals into changes in a 3- to 15-psig air signal, to position a pneumatic control valve or positioner. Simplified design features bumpless auto/manual transfer; self-locking/unlocking in power loss and recovery.

For more information
See L&N Publication C12.1232-DS

BLUE LINE™ Motor Positioners



Our Blue Line Motor Positioner operates raise/lower contacts to regulate a drive motor such as the L&N 10260- and 10210-Series. Responding to current outputs from controllers, retransmitting slide-wires, DDC, computer or micro-computer (PC) systems, it accommodates typical controller ranges of 4-20 mA, 1-5 mA, 10-50 mA, etc. The Motor Positioner can be used in "master/follower" control arrangements with or without a bias offset. It can also cause the drive motor to move to a pre-set "fail-safe" position.

For more information
See L&N Publication C12.1250-DS

11906 Zero-Voltage-Firing SCR Power Package

Compact and economical, our 11906 Solid-State Power Package provides dependable a-c input to electric heating elements. Used with a duration-adjusting-type (D.A.T.) or on/off controller, it employs a unique zero-voltage-firing circuit which effectively inhibits the generation of radio frequency interference. The Power Package efficiently modulates its on and off times at the highest possible repetition rate to reduce thermal stresses on heater elements thereby extending heater life.

For more information
See L&N Publication C12.1144-DS

7084 Microprocessor pH Analyzer/Controller

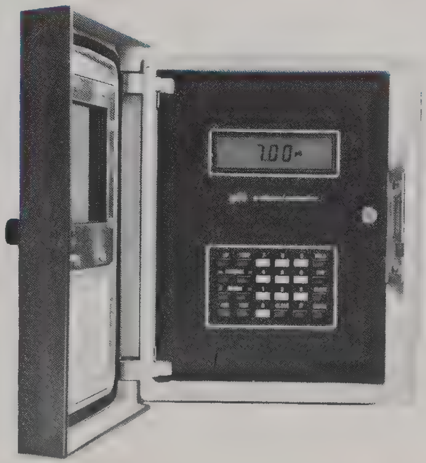
This unique microprocessor-based Analyzer/Controller assures faster, more accurate and more versatile pH (or ORP) analysis and control. For example, it will characterize pH to match your process-titration curve for more-precise proportional control. Field-selectable current-, time-proportioned, or pulse-frequency-control outputs are standard in a single model. It can be configured for feedback or feedforward control. The 7084 also provides extensive self-diagnostics plus the exclusive ELECTROLERT™ electrode failure alarm. Its two LCDs show pH, flow, temperature, set points, as well as Auto/Manual control status.

For more information See L&N Publication C2.1213-DS.

7083 Microprocessor pH Analyzer

With its bold liquid crystal display of pH, process temperature, alarm/control set points, status and diagnostic messages, the 7083 provides dependable measurement and control. It has dedicated pushbuttons on the front panel for all functions and settings. The 7083 provides isolated voltage or current outputs corresponding to the selected pH span. It also features the unique ELECTROLERT™ monitoring of electrode failure. Reliably accurate, the 7083 includes all application-oriented "options" as *standard* features in a single microprocessor-based model. Exceptionally easy to install, use and maintain, the 7083 meets Class 1, Division 2, Group B, C and D requirements. Housed in watertight NEMA 4X case.

For more information See L&N Publication C2.1212-DS.



7082 Microprocessor pH/ORP Analyzer

The 7082 offers many advanced features in a reliable and low-cost instrument. Its LCD shows pH/ORP, temperature, alarm condition, alarm setpoints, standardize/slope and output limits with 0.01 pH or 1 mV resolution. It accepts inputs directly from L&N pH electrodes or from an appropriate pre-amplifier. Its optional isolated voltage and current outputs can represent any pH/mV range within −2.00 to 14.00 pH or −1999 to 1999 mV. Proportional control of batch processes is possible. There are two 3A relays for alarm or On-Off control. The microprocessor-based 7082 also features extensive on-line self-diagnostics plus unique temperature compensation of solution pH. Weatherproof and corrosion-resistant, the compact RFI/EMI-shielded case withstands process wash-down.

For more information See L&N Publication C2.1211-DS.

pH/ORP Analysis

7073-33 Industrial ORP Analyzer

Used with an L&N electrode mounting to measure ORP of various liquids, the 7073-33 Analyzer does not require a preamplifier. An isolated output can represent ORP spans of 1000 mV, 800 mV or 400 mV. Alarm/control relays are available as separate plug-in components. The 7073-33 is housed in a water-tight NEMA 4X case.

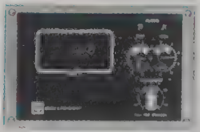
For more information
See L&N Publication C2.1119-DS

7073-6X Multi-Channel pH/ORP Analyzer

This very versatile analyzer measures pH or ORP from two to six channels simultaneously and indicates any one selected by switch. Used with L&N's electrode mountings equipped with a preamplifier. The continuous real-time 0-1 V output signals are suitable for display on multipoint recorders; auxiliary 0-10 V outputs are available to drive alarm/control circuits.

For more information
See L&N Publication C2.1120-DS

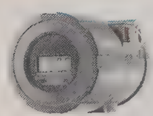
7075-7076 pH/ORP Analyzers



These two analyzers are inexpensive and simplified for low-cost measurement and control of industrial pH or ORP. The 7075 displays the measured values on a high-visibility analog scale; the 7076 employs a 3½ digit, LED display. Graduated knobs are used to set high and low limits. Red lights signal alarm or control conditions. Voltage outputs are standard and isolated current outputs are optional.

For more information
See L&N Publications C2.1121-DS (7075) or C2.1122-DS (7076).

7079 pH/ORP Transmitter



The 7079 is a cost effective two- or four- wire transmitter that produces an isolated 4-20 mA output signal proportional to a pH or ORP input. It provides any switch-selectable 2, 4, 6, 8, 10, 12 or 14 pH span over the entire 0-14 pH range, or any 400, 600, 800, 1000, 1200 or 1400 mV span. Available with an optional, liquid crystal display, the 7079 is FM approved intrinsically safe for Class 1, Div. 1, Groups A, B, C and D. Plastic (NEMA 4X) or explosion-proof cast-aluminum (NEMA 4) case.

For more information
See L&N Publication D2.1141-DS

Blue Line pH/ORP Rack-Mount Transmitter

Offering many features similar to the 7079 Transmitters, the L&N Blue Line pH/ORP Transmitter is an ideal cost-effective approach for 19″ rack mounting whenever a quantity of transmitters are needed. They can be used with a number of L&N electrodes and mountings with preamplifiers to handle a variety of water and wastewater applications.

For more information
See L&N Publication D2.1142-DS

7417 Portable pH Meter

Not merely a portable instrument, the 7417 is a complete portable pH lab that embodies the features of a high-quality bench-type instrument. Its 5-inch meter indicates ranges for pH and millivolts, plus monovalent and divalent cations and anions. Battery-operated in rugged aluminum case with all supplies stored in lid.

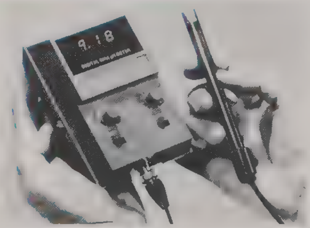
For more information
See L&N Publication B2.1126-DS

7409 Laboratory pH/ORP Meter

Ideal for industrial and laboratory use. Has slanted front panel with easy-to-read 7-segment LED display. Controls include a 3-piston switch to select millivolts, standby or pH mode; 0-100 C temperature compensator. Sturdy metal cabinet. Input connections for both BNC and US standard electrode plugs.

For more Information
See L&N Publication B2.1123-DS

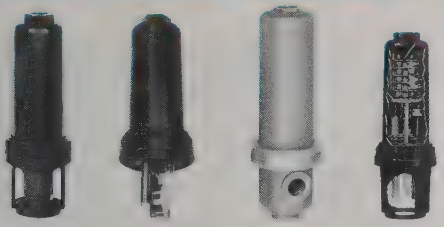
55 Mini pH Meter



Small in size—big in performance. Model 55 presents $5/16$″ red LED display of true .01 pH resolution over the full 0-14 pH range. Fast response, normally 90% of pH value within two seconds. Completely portable; weight only 11 ounces with DURAPROBE™ combination electrode and batteries. Ideal for all normal pH measurements in field, plant, lab or classroom.

For more information
See L&N Publication B2.1123-DS

7773 pH/ORP Electrode Mountings

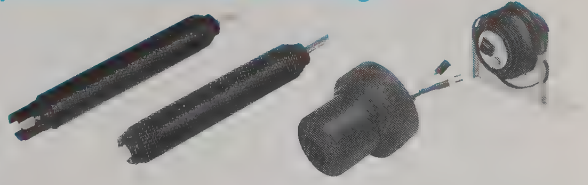


This versatile series of electrode mountings uses interchangeable parts. . .requires minimum maintenance. Change of only one screw-on part modifies unit for flow or immersion use. Made of 316 stainless steel, glass-fiber-reinforced polypropylene or Ryton*, 7773 units are available with preamplifier and optional ultrasonic cleaner. Units are FM Approved intrinsically safe when used with L&N 7079 transmitters for Class 1, Div. 1 or 2, Groups A, B, C and D; operate at high temperatures and pressures.

For more information See L&N Publication D2.1119-DS

**Trademark of Phillips Petroleum Co. for polyphenylene sulfide resin.*

7777 MEREDIAN® II Combination pH/ORP Electrode Mountings



MEREDIAN II pH Electrodes deliver long-term accuracy, with minimum maintenance. Designed for either in-line or immersion applications, the 7777 one-piece RYTON* body supports the rugged MEREDIAN II Combination (measuring and reference) electrodes and integral temperature compensator. Choice of glass formulations provide ***uncompromised performance*** over 0-80 and 20-110 C ranges—up to 100 psig at 50 C. Quick-disconnect permits easy replacement. Preamplifier modules available for all L&N pH instruments.

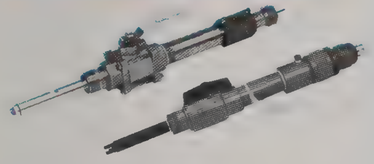
For more information See L&N Publication D2.1134-DS

7776 Immersion Mountings for MEREDIAN® Combination Electrodes

Our 7776 Immersion Mountings are ideal for use in even very corrosive solutions at pressures up to 100 psig and temperatures up to 266 F (130 C). Available with an optional preamplifier and temperature compensator that can be attached to the electrode holder by either a ½″ immersion support pipe or a flexible hose.

For more information
See L&N Publication D2.1131-DS

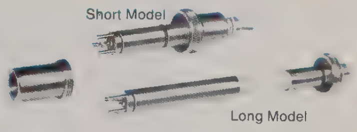
7774 Insertion/Removal Mounting for MEREDIAN® Combination Electrodes



Using a 7774 assembly, an operator can safely insert or remove a MEREDIAN pH or ORP electrode without interrupting a process. Designed for use in any position, in a pipeline, tank wall or other vessel, the 7774 is effective at pressures up to 100 psig. Available in CPVC plastic (with purge port for cleaning) or 316 SS.

For more information
See L&N Publication D2.1133-DS

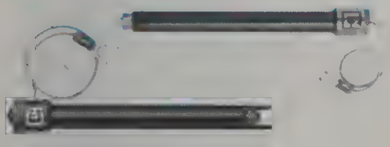
7775 Sterilizable Insertion Mounting for MEREDIAN® Combination pH Electrodes



Supplied with a standard dimension 316 SS bushing for welding into a vessel wall or process pipeline. The electrode holder is then inserted through the bushing into the pipe or vessel; maximum insertion depth to 11 feet. A threaded cap-nut with O-ring seal locks the assembly into place. Pressure limit 50 psi @ 130 C, 100 psi @ 60 C. Preamp available.

For more information
See L&N Publication D2.1132-DS

pH/ORP Electrodes, Accessories and Chemicals



A large selection of separate measuring and reference electrodes are available from L&N for virtually every industrial application. You'll find measuring electrodes of pH-sensitive glass or antimony for a variety of temperature ratings; gel or slurry-filled reference electrodes in Ryton or glass body. Also available are automatic temperature compensators, accessories and buffer solutions.

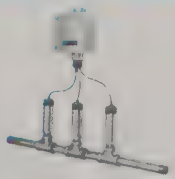
For more information
See L&N Publication D2.0003-BR

7779 Electrode Mounting for Oily Water Applications

The straight-through design of the 7779 promotes self-cleaning of electrodes and reduces fouling from oily water solutions. All wetted parts are chemically resistant, high-temperature polypropylene. The mounting is easy to install and maintain. It contains a stable, reliable preamplifier and uses a non-flowing ceramic-junction reference electrode. FM Approved intrinsically safe for Class 1, Division 1 or 2, Groups A, B, C and D when used with 7079 Transmitter.

For more information
See L&N Publication D2.1118-DS

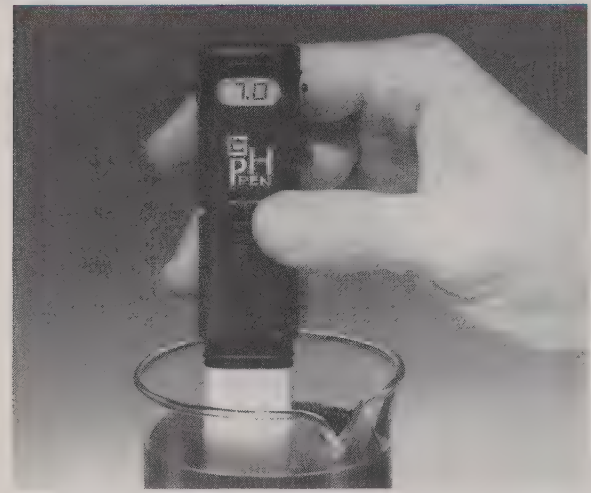
7758 Pipeline Mountings for pH/ORP Electrodes



Widely used in pipelines for measurements of pH or ORP or with MEREDIAN® Single-Probe Measuring/Reference Electrode, 7758 Mountings are ideal for use in piped heavy slurries. Self-cleans where oil and sludge tend to coat electrodes. Choice of 316 SS or polypropylene wetted parts resists most chemical attack and may be used at high temperature and pressure.

For more information
See L&N Publication D2.1121-DS

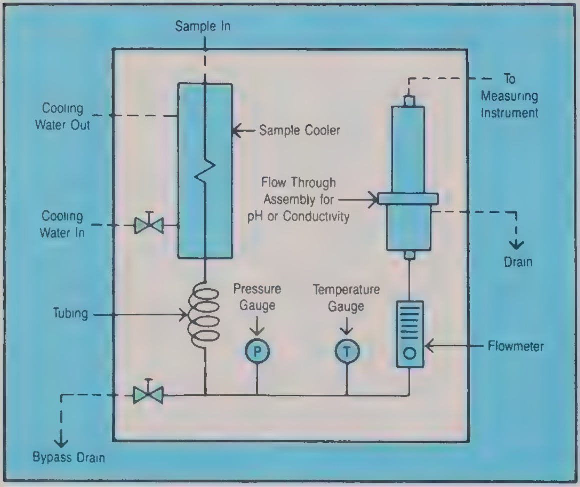
pH & MICRO MHO PENS™



These miniaturized, battery-operated, high-quality meters give you dependable and accurate pH or conductivity measurements in the lab or field. They're the first precise pH or conductivity meters that ***really*** fit in your pocket. To use, simply remove a cap, immerse the probe in the test liquid and the readout appears on an easy-to-read liquid crystal display. It's as simple as that!

For more information See L&N Publication B2.1122-DS.

7979-Series Liquid Sampling Panels

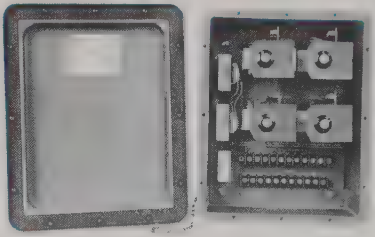


Typical panel configuration for high pressure

This economical series of 12 "pre-packaged" sampling panels includes all components mounted, piped and tested. They permit simplified assembly of liquid analysis systems for pH, conductivity, dissolved oxygen and other applications requiring sample conditioning. Various functional panels are available for sample pressures up to 4000 psi; all include our highly efficient 741376 Sample Cooler.

For more information See L&N Publication D2.0001-DS.

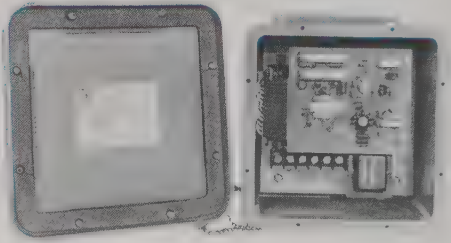
7080 Alarm/Control Module



Up to four plug-in alarm/control relays can be accomodated in our 7080 Module. Designed for use with L&N Analyzers, it can also be used with any other device having a 0-10 V or 4-20 mA output. The 7080 can accept one or two input signals. Various combinations of "High" and "Low" alarms and 1, 3 or 5% deadband are field selectable.

For more information See L&N Publication C12.1390-DS.

099230 Isolated Output Module



Designed for use with any devices having a 0-10 V dc output, the 099230 Module combines an efficient isolated-output printed circuit and power supply in a NEMA 4X case. The module offers a choice of six field-selectable outputs: 0-16, 4-20, 0-20, 5-25, 0-40, or 10-50 mA.

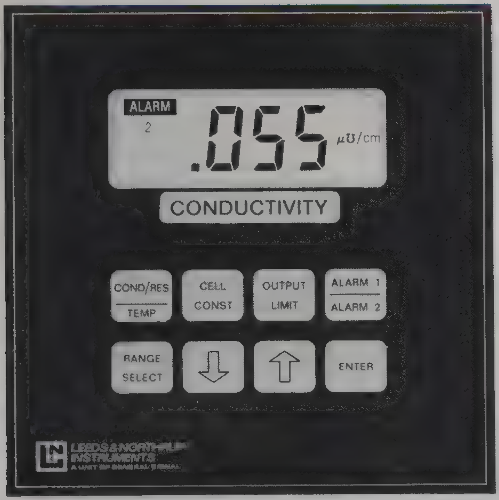
For more information See L&N Publication C12.1390-DS.

Blue Line™ pH/ORP Preamplifier Module

Our Blue Line Preamplifier provides stable, reliable electrode signal amplification for pH or ORP measuring electrodes. A unique guarded circuit protects the electrode input and produces a thousand-fold decrease in sensitivity to electrical leakage. Automatic temperature compensation and lightning protection available.

For more information See L&N Publication C12.1391-DS.

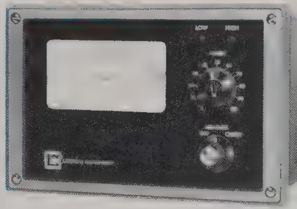
7082 Conductivity/Resistivity Analyzer



Designed for use with industry-proven L&N conductivity cells, the 7082 assures fast, accurate, reliable analysis. It provides true, high purity water temperature compensation for deionized water. It also has a special algorithm for higher accuracy in power industry ammoniated and "cation conductivity" samples and for semiconductor acid etch rinse measurements. Functions digitally set from the front panel include output range, alarm setpoints, cell constant selection, plus trim and system calibration. LCD shows conductivity/resistivity, temperature, setpoints, and status messages.

For more information See L&N Publication C2.2211-DS.

7077 Wide-Range Conductivity Analyzer



This high-performance wide-range instrument provides ranges from 0-1 to 0-1,000,000 µmhos/cm as well as direct reading acid, caustic and salt concentrations for ion exchange regenerant measurements. All ranges have automatic temperature compensation. Signal lights indicate alarm status.

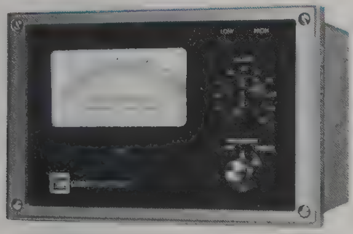
For more information See L&N Publication C2.2115-DS.

7078 Conductivity and Ratio Analyzer

Perfect for accurate measurements of conductance or resistance ratios of solutions. Temperature-compensated measurements of inlet and outlet streams. Wide variety of ratio ranges for reverse osmosis and deionizer application requirements. Front-of-panel alarm signal lights and calibration check switch.

For more information See L&N Publication C2.2116-DS.

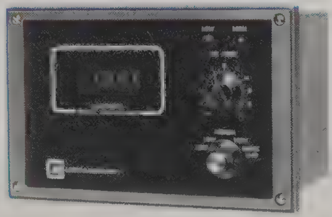
7075 Conductivity Analyzer



The 7075 Analyzer is a low-cost instrument specifically designed for water treatment systems. Its wide spans check both raw and treated water on the same scale. Automatic temperature compensation on a variety of ranges. Front-of-panel calibration switch and signal lights. NEMA 3R and 12 plastic case.

For more information See L&N Publication C2.2112-DS.

7076 Multi-Range Conductivity Analyzer



Micromhos/cm or ohms-cm are easy to read on the 7076 Analyzer's LED digital display. Switch selected X-1, X-10 and X-100 ranges all have automatic temperature compensation. Conductivity ranges to 0-200,000 µmhos/cm. Calibration check switch and alarm signal lights on front of corrosion resistant case.

For more information See L&N Publication C2.2114-DS.

7073 Rugged-Duty Conductivity Analyzer

To meet OSHA Class 1, Div. 2, Group B, C or D requirements, the 7073 Analyzer is supplied with hermetically sealed relays. Nine ranges (X1 to X500) can be changed in the field using convenient pin-jacks. Isolated current outputs of 0-16, 0-20, 0-40, 4-20, 5-25 and 10-50 mA are optional; 0-1 and 0-10 voltage outputs are standard. Numerous conductivity, resistivity and direct reading concentration ranges to choose from.

For more information See L&N Publication C2.2113-DS.

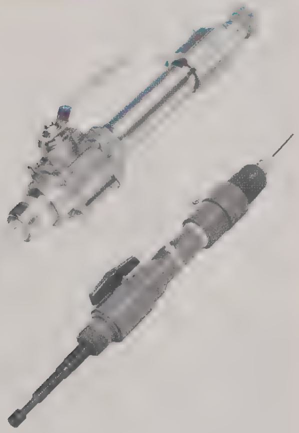
Conductivity/Resistivity Analysis

4973-Series Conductivity Cells

Ruggedly constructed of polyethersulfone (PES) for high corrosion resistance, 4973 Cells provide reliable, continuous measurements in industrial water processes at temperatures up to 284 F (140 C) at pressures up to 250 psig. They have titanium electrodes (for 0.01 and 0.1 cell constants) or high-density carbon (for 1.0 and 10.0 cell constants). The 4973 can be mounted for flow or insertion applications, or used for dip-type batch sampling.

For more information
See L&N Publication D2.2115-DS

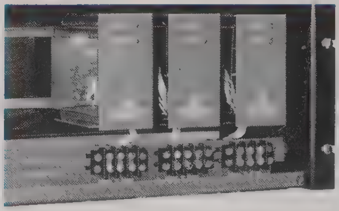
4909-Series Pressure Insertion/Removal Cell Assemblies



Without interrupting the process, our 4909 conductivity cells can be conveniently inserted or removed under pressure and temperature coefficients as high as 50 psig (345 kPa) and 284F (140 C). The rugged industrial-type assembly provides primary and back-up "stops" to protect the operator during insertions or removals. Available in CPVC plastic with a purge port for flushing-out debris, or 316 stainless steel.

For more information
See L&N Publication D2.2115-DS

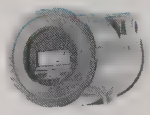
Blue Line™ Rack-Mount Conductivity Transmitters



Wherever a number of transmitters are needed, our Blue Line model will give you higher-density configurations, greater cost-effectiveness and installation flexibility. Fits standard 19″ rack (up to six modules across) or bolts to wall. Functions similar to 7079 Conductivity Transmitter.

For more information
See L&N Publication D2.2142-DS

7079 Conductivity/ Resistivity Transmitter



This cost-effective two- or four-wire transmitter produces an isolated 4-20 mA current output signal proportional to the selected range (conductivity or resistivity). It is ⟨FM⟩ Approved explosion-proof (with aluminum case) and intrinsically safe. All models provide switch-selection of ranges. An optional integral 120 V ac power supply is available. Calibration check switch and digital display is standard.

For more information
See L&N Publication D2.2141-DS

4902-Series Conductivity Cells

Our 4902-Series Cells feature cell constants as low as 0.001 cm^{-1}. Designed primarily for water-treatment applications they can be inserted directly into a pipe or vessel at pressures up to 200 psig, temperature to 100 C. The 4902 can also be supplied with a right-angle PVDC plastic flow-assembly having threaded inlet and outlet connections. Automatic temperature compensation is optional.

For more information
See L&N Publication D2.2114-DS

7085 Conductivity/ Resistivity Controller

Rugged, compact, accurate and dependable, all describe our low-cost 7085 Conductivity/ Resistivity Controller. It has a dual-range switch (1:10); wide choice of ranges; solid-state circuitry with alarm/control functions; automatic temperature compensation. Signal lights indicate safe operation or alarm status. Companion 7086 cells (described in data sheet), for use to 284 F (140 C), require only routine cleaning.

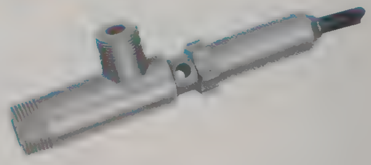
For more information
See L&N Publication C2.2117-DS

4905-Series Conductivity Cells

Our 4905 Cells are perfect where high corrosion resistance is needed. Supplied with either nickel or platinum electrodes, with cell constants up to 50, they adapt readily to insertion, immersion or flow applications. The 4905 cells withstand pressures up to 250 psig @ 284 F (140 C).

For more information
See L&N Publication D2.2115-DS

4800-Series Conductivity Cells

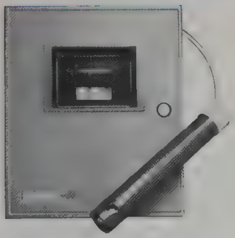


High corrosion resistance and rugged configurations enable our 4800-Series Cells to provide continuous and reliable measurements in industrial processes. Available for a variety of cell constants from 0.01 to 50 cm^{-1}. There are 4800's for insertion or immersion applications at pressures up to 200 psig. Optional ATC.

For more information
See L&N Publication D2.2114-DS

Dissolved Oxygen Analysis

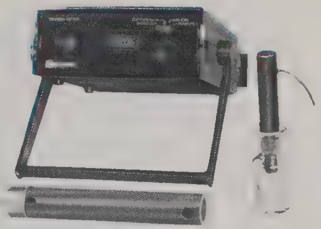
7931 Dissolved Oxygen Analyzer



Our 7931 D.O. Analyzer performs accurate and continuous monitoring of the true concentration of dissolved oxygen in boiler, process, or wastewater. Its unique patented probe, unaffected by fouling or changes in flow conditions, features a permanent heavy-duty membrane that requires no replacement. Normal cleaning is the only maintenance. The 7931 is housed in a NEMA 4X weatherproof case for outdoor use. Its switch-selected 4″ meter displays parts per million or billion, plus calibration. Isolated current or voltage outputs and an alarm with relay contacts are provided.

For more information See L&N Publication C2.3114-DS

7932 Portable Dissolved Oxygen Meter



Unique in both configuration and operation, our 7932 is ideal for either field or laboratory use to accurately measure dissolved oxygen in wastewater and other liquids. Powered by two standard 9-volt cells, the meter has a companion wastewater or BOD probe. A high-impact-resistant ABS plastic case houses the probe and its 20-foot cable. Calibrate against liquid standard or air.

For more information See L&N Publication C2.3113-DS

Sodium Ion Analysis

L&N Sodium-Ion Measuring System

This highly sensitive system is used to detect condenser leaks and boiler carryover, breakthroughs in ion-exchange equipment, evaporator entrainment, and sodium content in potable water. It will produce continuous automatic measurement of the sodium ion concentration in aqueous solutions over any 3-decade (logarithmic) span between 0.1 part per billion and 100,000 per million. The system consists of an Analyzer, a Monitor, a Calibrating Facility and, if desired, a SPEEDOMAX Recorder.

For more information See L&N Publication C2.1114-DS

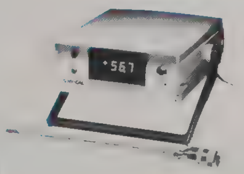
Humidity

BLUE LINE™ Relative Humidity Transmitter

With rugged electronics housing of cast aluminum alloy and a stainless steel sensor probe, our 2-wire Blue Line R. H. Transmitter performs reliably, even when in contact with common organic solvents, dirt, dust, oils, mild acids or caustics. Ideal for virtually every industrial use, it produces a 4-20 mA output. Optional analog meter and power supply.

For more information
See L&N Publication C7.3133-DS

760-A Humidity Indicator



Manufactured by Hy-Cal Engineering*, the 760-A with its companion 3552-B Probe is a self-contained package that will give a direct reading over the full 0 to 100% RH range. It features a 3½ digit readout, standard analog or optional BCD output. The plastic case and washable probe withstand contaminants such as salt, oil, and dust.

* A Subsidiary of Leeds & Northrup

For more information See L&N Publication C7.3113-DS

L&N RH PEN™

Our small RH PEN is a completely self-contained relative humidity meter. Pocket-sized convenience makes it easy to carry anywhere. Under normal use, the RH PEN will operate for over six months on standard watch batteries. Fully dependable, it operates over a range of 0 to 90% RH at 0 to 50 C.

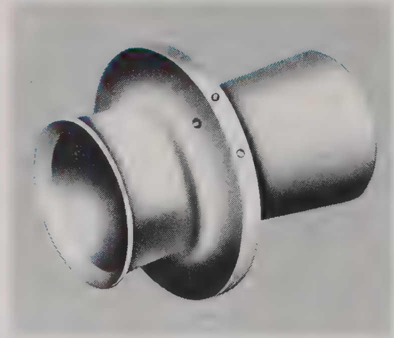
For more information See L&N Publication C7.3114-DS

BIF® Universal Venturi Tubes

Model 181-Cast Iron

Standard sizes from 2″ up. High tensile cast iron bodies with bronze throat, 125 or 250 psig. ASA flanged ends. Low head loss and guaranteed uncalibrated accuracy of ±0.50%.

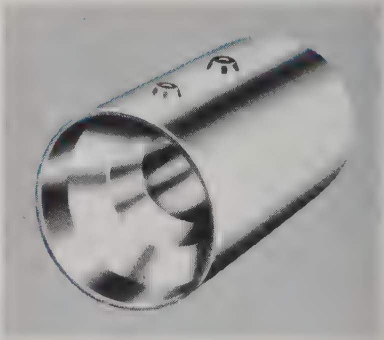
For more information See L&N Publication 180.20-4



Model 182-FRP

Standard sizes from 2″ up. Corrosion resistant, low cost fiberglass reinforced polyester. Standard or high temperature, up to 300°F. Mounting between 150 or 300 psig. flanges. Low head loss and guaranteed uncalibrated accuracy of ±1.0%

For more information See L&N Publication 180.20-4

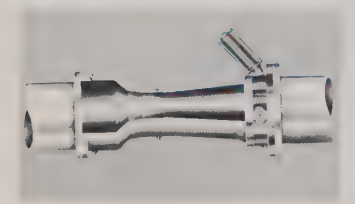


Model 183-Fabricated

Available in a varied selection of corrosion resistant materials. Custom designed UVT is available in wide range of sizes. Low head loss and guaranteed uncalibrated accuracy down to ±0.75%

For more information See L&N Publication 180.20-4

Universal Flow Controller



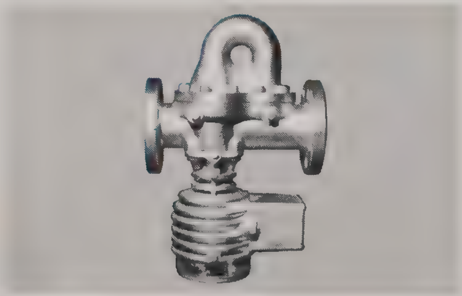
Model 610 Universal Venturi Controller combines the reliability of a UVT with a butterfly valve in an integral design for dependable flow measurement and control in water and wastewater. The UVT is designed to produce a steady differential pressure and the valve is sized to achieve optimum control. Electric or cylinder operator. Single source responsibility provides an optimum loop for stable rate-of-flow control. System accuracy is ±3% over an 8 to 1 range.

For more information See L&N Publication 610.201-1

SBF II™ Flow Metering System for Solids-Bearing Fluids

Model 189 SBF II Flow Metering System is specifically designed for flow measurement of solids-bearing fluids such as wastewater or light slurries. It consists of an UVT primary with a Model 251-19 electronic flow transmitter. Differential pressures produced by the UVT are statically sensed by sensors that are mounted flush with the inside of the UVT. The system eliminates clogging or contaminant build up. Model 251-19 produces a 4-20 mA dc signal. System accuracy is ±1.0% over a 10 to 1 range.

For more information See L&N Publication 189.20-1



Shuntflo® Steam/Gas/Air Flowmeters

Model 0402 Shuntflo Meters are axial turbine, totalizing meters for steam, air, sewage gas or other gases. Self contained and self operated, the Shuntflo Meter requires no external power for the basic unit with a direct reading counter. A digital/analog output is optional. Sizes from 1″ to 24″. Accuracy is ±2% of actual flow.

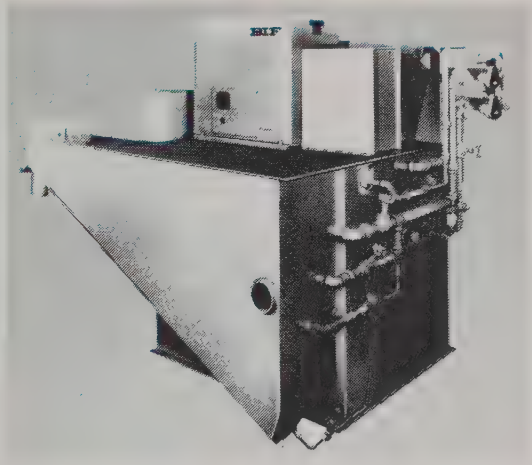
For more information See L&N Publication 400.20-4

BIF® Volumetric Dry Material Feeders

BIF Series 25 Volumetric Dry Material Feeders meter a wide variety of products ranging from fine powders to course mixtures. They utilize a progressive-pitch, open-spiral helix that moves material with less compaction than solid screw or constant-pitch type helix units. Feeding rates are accurate to ±1% by volume or 3% by weight depending on material.

For more information See L&N Publication 25.20-1

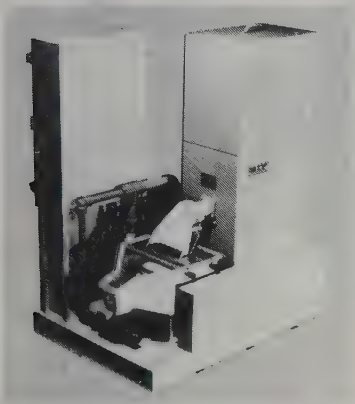
BIF® Lime Slakers



BIF Lime Slakers offer a simple efficient method of slaking lime in the proper proportions for complete chemical reaction at the correct temperature and viscosity. Available in models with maximum capacities of 500 to 10,000 lbs per hour over a 10 to 1 range.

For more information See L&N Publication 41.20-1

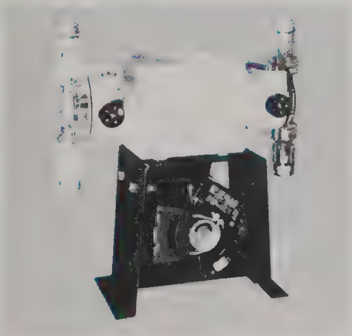
BIF® Polymer Feeding System



The BIF "Polypak" System features a unique drum-type wetting device and vibrating spreader. The system assures maximum efficiency in preparing polyelectrolytes. Available for large or small installations, it mixes polymer rapidly, automatically, uniformly.

For more information See L&N Publication 28.20-1

BIF® Metering Pumps

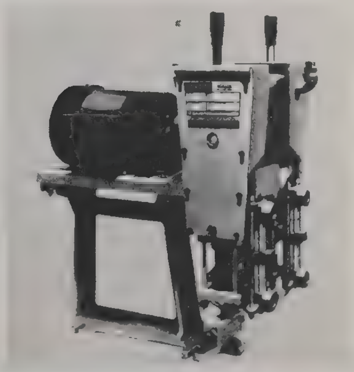


1200-Series Mechanical Diaphragm Metering Pumps Designed for long-life and trouble-free operation, these rugged pumps feed a wide range of chemical solutions safely and dependably. Unusual diaphragm design eliminates loss of pumped fluid; permits dry placement of diaphragm, no oil spillage. Available in simplex and duplex models. Capacities to 24 GPH per head vs. pressures to 125 psig.

For more information See L&N Publication 1200.20-1

1700-Series Hydraulic Diaphragm Metering Pumps This versatile series of pumps offers a variety of liquid ends to handle difficult chemicals and slurries. Featuring the unique "Propsuperb" design, these proportioning pumps start-up and operate with trouble-free dependability and low maintenance. Available in simplex or duplex models with automatic controls. Capacities to 370 GPH per head vs. pressure to 4000 psig.

For more information See L&N Publication 1700.20-3



MICROTRAC™ Particle Size Analyzers

11:37 SELECT...

MICROTRAC II

Our innovative MICROTRAC Analyzers measure particle size by projecting a laser beam through a sample stream where the beam is scattered by the particles. An optical detector measures the scattered light. The resulting signals are processed through a micro-computer. A typical analysis takes only about 10 seconds; the sample is mixed, transported, measured, analyzed, and the results are printed out. Menu-selectable data includes any combination of (a) raw data, (b) summary data, (c) tabular data of relative and cumulative distribution, and (d) graphic data of distribution. All data is accompanied by a two-level sample identifier, date and time.

For more information See L&N Publication C4.7127-BR

MICROTRAC® On-Line Particle-Size Monitors

Based on the same proven principle as our industry-leading MICROTRAC Particle-Size Analyzer, this monitor may be connected directly to a single or multipoint sampling system. It will automatically regulate sampling and provide particle-size distribution data reliably, continuously and unattended. Models available for a wide variety of materials, wet or dry, between 1.9 and 300 microns. Output signals feed back for particle size-control.

For more information
See L&N Publication C4.7125-FL

MICROTRAC® Data Management Software

Designed for IBM (or compatible) PC. Automatically collects and stores data from MICROTRAC Analyzers or On-Line Monitors. Blends data from several ranges. Produces particle-size distribution graphs. Performs statistical analysis on any desired grouping of data (linear regression, standard deviation, coefficient of variation). Up to 24 channels, 3 sample identifiers, 8 parameters, and 2 lines of remarks can be displayed. Output to printer or color plotter.

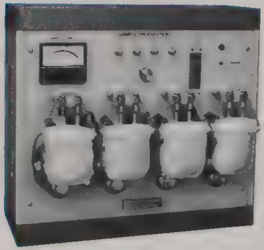
For more information See L&N Publication C4.7126-DS

4200 Surface Area Analyzer

Our Model 4200 automatically provides B.E.T. surface area measurements in less than five minutes. It accepts samples with surface areas ranging from below 0.15 to over 4000 square meters per gram. Utilizing nitrogen adsorption and dynamic flow principles, the 4200 accurately analyzes and displays a readout of total surface area in square meters. Features automatic temperature control.

For more information See L&N Publication C4.7128-DS

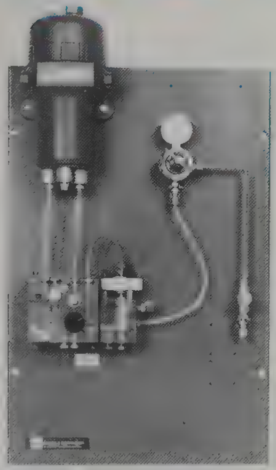
4201 Sample Prep Facility



Where a large number of samples must be analyzed continuously, our 4201 Four-Station Sample Preparation Facility utilizes the same techniques employed in the sample preparation station in our analyzer. Separate valves and controllers permit individually regulated outgassing for each sample. Prepared samples are sealed from the atmosphere once they are removed for measurement.

For more information See L&N Publication C4.7128-DS

L&N Triple-Range Hydrogen-Purity Analyzer for Hydrogen-Cooled Generators

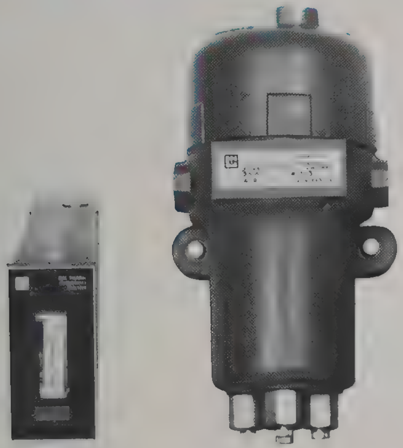

Modular Gas-Sampling System with 7866 Analyzer Sensing Unit mounted on panel

Control Unit

LEEDS & NORTHRUP
Remote Indicator (Optional)

Our unique triple-range 7866 Thermal Conductivity Analyzer is ideal for monitoring the use of hydrogen coolant in large power generators such as used by electric utilities, paper mills, chemical plants as well as cogeneration facilities. The equipment helps avoid the formation of explosive gas mixtures by continuously monitoring coolant and purge gases for alarm conditions. Its three switch-selected ranges precisely measure 0-100% CO_2-in-Air during the generator start-up phase, 100-75% H_2-in-Air during normal generator operation and 0-100% CO_2-in-H_2 during the purging of the H_2 coolant when the generator is being shut down. The equipment includes a prepackaged Sampling System, an Explosion-Proof (Div. 1) Sensor Unit for mounting at the sampling point and a Control Unit for panel-mounting up to 1000 feet away from the sensor. An optional Remote Indicator is also available. The L&N Hydrogen-Purity Analyzer can be easily retrofitted into GE or Westinghouse generator systems. **For more information** See L&N Publications C3.1111-DS (Analyzer) and C3.1112-DS (Remote Indicator & Sampling System).

7866 Thermal Conductivity Analyzer

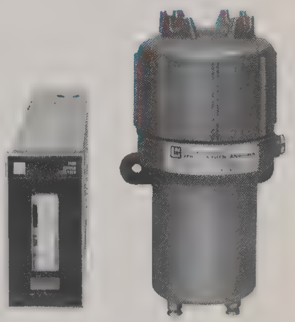


Featuring high speed of response, high sensitivity and excellent stability, our thermal conductivity analyzer is ideal for critical applications involving binary mixtures. It's split-architecture design employs an explosion-proof or general-purpose Sensing-Unit/Transmitter mounted at the sampling point, and a Control Unit/Receiver panel-mounted as far away as 1000 feet and connected to the Sensing Unit by unshielded cable. The 7866 provides a choice of current or voltage output signals and can be equipped with an indicating meter and/or optional alarms and inherently fail-safe relay to initiate shutdown of the process. Also available are a variety of pre-mounted, interconnected and prewired sampling systems.

For more information See L&N Publication C3.1111-DS

7863 Thermomagnetic Oxygen Analyzer

Employing the magnetic-attraction characteristics of oxygen, our 7863 Analyzer quickly and accurately analyzes uncombined O_2 in various background gases. It is highly reliable as a guide to combustion efficiency or O_2 impurity in inert gases. Its modular construction and solid-state circuit design result in minimum maintenance. Used with 7872 Prepackaged Sampling Systems.



For more information
See L&N Publication C3.1121-DS

7867 Total Combustibles Analyzer

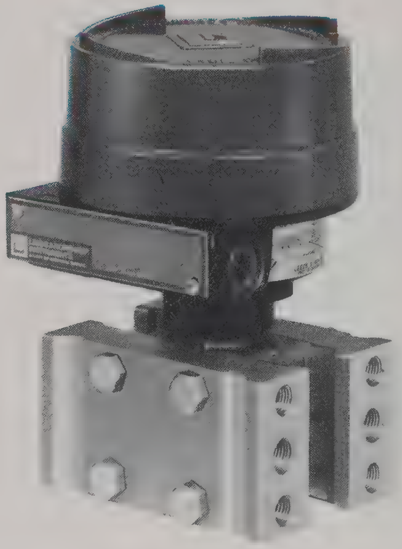
Our highly efficient 7867 accurately analyzes flue gases and other oxygen-deficient gases to determine the total concentration of combustible gases or the lower flammable explosive limits of selected solvent vapors in air. Wheatstone bridge circuit and stainless steel cell block assembly in NEMA-4 housing. Remote Control-Unit/Receiver.

For more information
See L&N Publication C3.1131-DS

2600-Series Electronic Pressure Transmitters

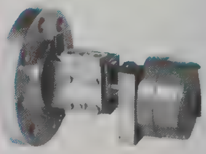
Leeds & Northrup's 2600 Series Transmitters give you superior accuracy. . .cost-effective versatility. . .unmatched reliability. . .outstanding value—whether you're measuring differential, absolute or gage pressure, flow or liquid level.

Why not see for yourself: Try one—in your toughest application. We're sure its outstanding features and performance will convince you that the L&N 2600 is a family of transmitters you can *really* depend on—for years to come!



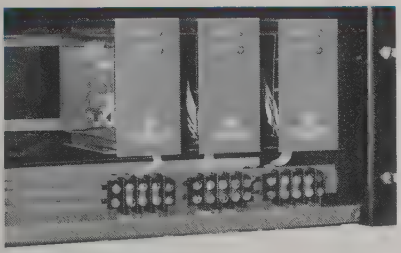
Features

- **Extreme accuracy <±0.1% typical/±0.2% max. Certified 0.1% accuracy available.**
- **Rangeability up to 9:1 without degradation in temperature or static pressure performance.**
- **Wide turndown - up to 10:1.**
- **Industry's broadest range of spans - 0.2″ W.C. to 6000 psi.**
- **Unmatched long life amplifier design - 400,000 hours calculated MTBF.**
- **Hastelloy C-276 diaphragms, standard; full choice of optional wetted materials.**
- **External zero, span and damping adjustments.**
- **Independent zero and span adjustment.**
- **Widest power supply operating range - 11-48 V dc.**
- **Virtual immunity to RFI interference.**
- **Compact and lightweight.**
- **Supported by a full range of options.**
- **Field calibratable using the 0.1% accurate LCD meter option.**
- **Choice of diaphragm seals, including sanitary.**

Standard Models		**2610 Differential Pressure 2620 Flow**	**2630 Gage Pressure**	**2640 Absolute Pressure**	 **2650 Liquid Level**
Input	Spans (Min./Max.)	0.2″ W.C. to 6200″ W.C.	3″ W.C. to 6000 psi	15″ W.C.A. to 8000″ W.C.A.	15″ W.C. to 6200″ W.C.
Output	Standard	4-20 mA dc into 0 to 650 ohms, operating on 24 V dc two-wire supply (an 1850-ohm load resistance can be accommodated by increasing the supply voltage to 48 V dc maximum). Signal is linear with pressure (2610, 2630, 2640 or 2650) or with the square root of the differential pressure (2620).			
	Optional	Reverse acting output (increasing output signal with decreasing input), a 10-50 mA, 0-40 mA or 0-16 mA output can be provided.			
	Optional Output Meter	An analog output meter, with a 0-100 linear and a 0-10 square-root calibration on the same scale, can be internally or remotely mounted. A 0.1% accurate LCD output meter with linear digital display can be internally mounted.			

For more information See L&N Publications D4.2601-DS (for entire group); D4.2611-DS (2610 ΔP & 2620 Flow); D4.2631-DS (2630 Gage Pressure); D4.2641-DS (2640 Absolute Pressure); and D4.2651-DS (2650 Liquid Level).

Blue Line Temperature Transmitters



Ideal for receiving, conditioning and transmitting signals from thermocouples (EMF), RTD's, RAYOTUBE® and SPECTRAY® radiation detectors. Each is available in two different housings: (1) a NEMA 4 ***field-mount*** style for on-site signal conditioning, and (2) an economical ***rack-mount*** version that provides cost savings when a number of transmitters are used. Blue Line Temperature Transmitters provide reliable 2-wire, 24 V dc operation with 4-20 mA output. They're very easy to calibrate with external non-interactive span and zero adjustments.

Thermocouple Transmitters accept inputs from most commercially available thermocouples in all commonly used ranges.

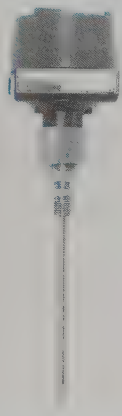
Resistance Temperature Detector Transmitters accept inputs from 2- or 3-lead RTD's including a 100 ohm platinum PT-385 and the ULTRA-7™ 1000 ohm RTD.

Radiation Thermometer Transmitters accept inputs from radiation detectors having a 24 mV output such as all L&N RAYOTUBE and SPECTRAY models. The 4-20 mA output of the transmitter is isolated from the preamplified low-level input.

Millivolt Transmitters accept any input span from 6 to 100 mV and can be used for temperature difference measurements using differential thermocouples.

For more information See L&N Publication No. D1.0411-DS.

Blue Line Relative Humidity Transmitter



With rugged electronics housing of cast aluminum alloy and a stainless steel sensor probe, the L&N Blue Line Relative Humidity Transmitter performs reliably, even when in contact with common organic solvents, dirt, dust, oils, mild acids or caustics. It is fast and accurate to ±1% R.H. within 10% of operating point at 25C and responds in only 16 seconds. The Blue Line R.H. Transmitter produces a 4-20 mA output. It is ideal for virtually every industrial use.

For more information
See L&N Publication C7.3133-DS.

7079 Transmitters for

- pH/ORP
- Conductivity /Resistivity

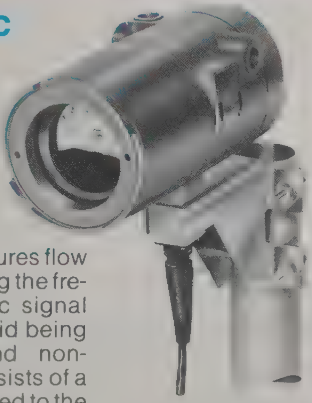
NEMA 4X Noryl Plastic Case

NEMA 4 Metal Case

The 7079 Transmitter is an economical 2- or 4-wire transmitter that's easy to install and simple to calibrate. It transmits an isolated 4-20 mA signal proportional to the input from a pH electrode or conductivity cell. Available in a wide variety of switch-selectable ranges, the 7079 is ⟨FM⟩ approved intrinsically safe for Class 1, Division 1, Groups A, B, C & D locations; explosion-proof for Groups C & D.

For more information See L&N Publication Nos. D2.1141-DS (for pH/ORP); D2.2141-DS (for Conductivity/Resistivity).

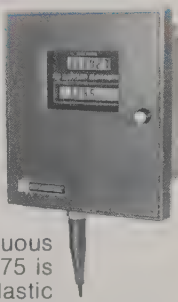
475-Series Ultrasonic Doppler Flowmeter



This economical flowmeter measures flow accurately and reliably by sensing the frequency change of an ultrasonic signal caused by the motion of the liquid being measured. Obstructionless and non-intrusive, the 475 Flowmeter consists of a sensor/transducer – easily clamped to the outside of any size pipe – connected by cable to a remotely mounted electronics housing. Its cost is independent of pipe size. It produces a 4-20 mA output, proportional to flow.

For more information
See L&N Publication C4.3111-DS.

775-Series Microprocessor Doppler Flowmeter



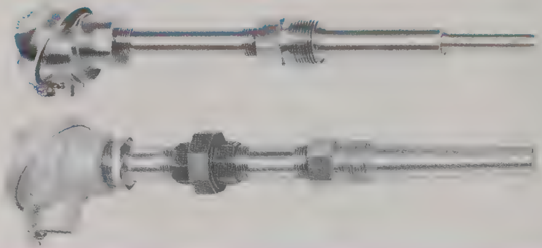
Every function you could want in a non-intrusive Flowmeter is provided as a standard feature in the 775-Series. There's a highly visible liquid crystal display (LCD) of flow, flow units, flow variables plus a self diagnostic program to verify correct operation. There's a 2nd LCD for continuous display of total volume. The 775 is housed in a NEMA 4X Noryl plastic case. A door provides access to a front-panel keyboard for entering functions such as batch, high and low alarm settings; calibration parameters; internal clock/calendar settings, circuit diagnostics; and more. The 775 also produces a 4-20 mA output proportional to flow for remote readout and/or control.

For more information
See L&N Publication C4.3112-DS.

3050-Series Thermocouple Assemblies in Thermowells

Our 3050-Series TC Assemblies are perfect for temperature measurements in high-pressure and/or severe-vibration applications such as found in chemical and petrochemical plants, and in water, steam and air lines in power plants. A broad selection of base-metal thermocouples and thermowells are available with single- or dual-elements, optional spring loading and a choice of mounting fittings. Convenient catalog-numbering system simplifies specifying as either complete assemblies or separate components.

For more information See L&N Publication D1.1111-DS



3060-Series Thermocouple Assemblies for Contact Temperatures

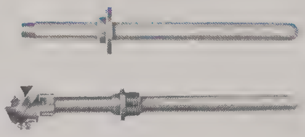
We offer this variety of outstanding thermocouple assemblies for tip-sensitive measurements of generator-, motor- or machinery-bearing temperatures, as well as any temperature application in which the thermocouple tip must be kept in firm contact with a surface for accurate measurement and fast response. Available options include spring-loading, single or dual elements, grounding or ungrounding, insulation types, heads, elements and mounting fittings. Easy to specify.

For more information See L&N Publication D1.1112-DS

3070-Series Thermocouple Assemblies in Metal Tubes

Our 3070-Series assemblies have the widest possible industrial application—wherever a base-metal thermocouple is needed in an atmosphere or fluid at ordinary pressures (up to 40 psig). Available are straight or angle-type assemblies with single or dual elements and a wide choice of protection-tube materials and sizes. Weather-resistant aluminum or heat- and moisture-proof cast-iron universal heads. Adjustable flanges or welded mounting bushings. Optional calibration checks at specified temperatures.

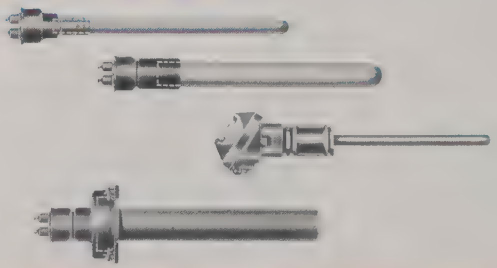
For more information See L&N Publication D1.1113-DS



3080-Series Platinum Thermocouple Assemblies

For critical industrial applications, our 3080-Series Type R, S, and B noble-metal thermocouples are predominantly used for temperatures between the upper limits of base-metal thermocouples and 3100F, and for more-precise measurements of lower temperatures. Ideal as reference standards in calibrating working thermocouples. A wide variety of assemblies are available in ceramic primary tubes, with optional ceramic or metal secondary tubes. Available as complete assemblies or individual components.

For more information See L&N Publication D1.1114-DS

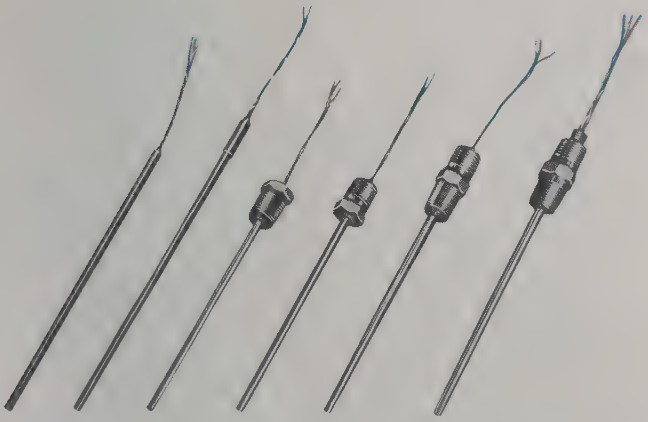


8784-Series Compacted-Ceramic-Insulated Thermocouple Assemblies

Used in maximum external pressures up to 50,000 psi at temperatures up to 1200 F. our 8784 "swaged" thermocouples offer the advantages of small size, fast response and longer life than wire-type couples. Supplied in integral lengths as long as 40 feet. Types E, J, K, S or T single or dual elements with exposed, grounded or ungrounded junctions, wide variety of sheath materials and sizes. Choice of miniature or universal terminal heads, quick-disconnect terminals or integral leadwire extensions.

For more information See L&N Publication D1.1118-DS

Resistance Temperature Detectors



This well-established line of precision industrial RTD's has an outstanding reputation for quality and reliability. Used with L&N resistance bridges for measurement and/or control, each unit employs a sensitive element of extremely pure platinum or copper wire that provides a definite resistance value at each temperature within its range.

RTS-30L/40L-Series features 100-ohm thin-film or wire-wound platinum elements for a wide variety of applications from −325 to +1000F (−200 to +535C). Assembled with high-purity alumina spacers in a metal sheath packed with magnesium oxide to prevent vibration of the leads. Large selection of thermowells, connectors, fittings and heads.

RTS-60L-Series gives accurate surface-temperature measurements in a low-profile design where space is limited. Available in six configurations designed for most applications from −320 to+900F (−200 to +480C). Available types include bolt-on, bendable and cement-in-place. Data sheet describes additional series.

For more information See L&N Publication D1.1002-DS

L&N BLUE LINE™ Temperature Transmitters

Ideal for receiving, conditioning and transmitting signals from thermocouples (EMF), RTD's and RAYOTUBE® and SPECTRAY® radiation detectors. Each is available in two different housings: (1) a NEMA 4 field-mount style for on-site signal conditioning and (2) an economical rack-mount version that provides cost savings when a number of transmitters are used. Blue Line Temperature Transmitters provide reliable 2-wire, 24V dc operation with 4-20 mA output. They're very easy to calibrate with external non-interactive span and zero adjustments.

For more information See L&N Publication D1.0411-DS

8627 Optical Pyrometer

Completely self-contained and featuring single-adjustment operation, our 8627-Series Optical Pyrometers are used for measuring temperatures from 1400 to 5200 F (775 to 2800 C). They're perfect for measuring tapping, teeming, and pouring temperatures of molten metals; for checking roofs, walls and flue-linings of furnaces, kilns and ovens; for determining temperatures of forgings while working; or of ingots, billets or strip while rolling. They are also used for laboratory and research applications and as a temperature standard to check the accuracy and calibration of other types of pyrometers. These hand-held instruments combine laboratory precision with the rugged construction required for industrial use, and provide rapid measuring speed, reliability and ease of operation. Employing the "disappearing filament" method of operation, the 8627 utilizes our L&N-designed optical pyrometer lamp with its long history of stability and reliability. Both the electrical circuit and optical system are contained in a lightweight cast-aluminum housing.

For more information See L&N Publication B1.4124-DS

18874/18875 Rayotube® Radiation Thermometers

These high-speed radiation temperature detectors are designed for accurate non-contact measurements of small-target areas (less than 0.1″) without interference from flames or hot gases. They provide a high level 4-20 mA output of measurements from 752 to 2552 F (400 to 1400 C) of stationary or moving targets. Usable in ambient temperatures up to 158 F (70 C) without cooling, or in high ambients with our optional air/water cooling jacket. Especially effective for measuring molten glass and similar applications, they are very easy to install and keep clean.
For more information See L&N Publication D1.3117-DS

FIBERAY™ Radiation Thermometer

Our FIBERAY Thermometers will accurately measure temperatures from 1472 to 2912 F (800 to 1600 C) in applications where physical contact or direct sighting is difficult or impossible, such as glass tanks, forehearths and induction furnaces. Equipment consists of a lens system in 316SS housing which can be mounted within 4″ of target, fiber-optic transmission cable, silicon photodiode detector and transmitter installed up to 10 feet away. Lens system withstands ambient temperature up to 1000 F (540 C).
For more information See L&N Publication D1.3118-DS

8886 SPECTRAY® Spectrally Selective Temperature Detectors

Two versions of our 8886-Series Spectrays permit a choice of spectral response: SPECTRAY-65 has an effective wavelength of 0.65 microns, range 1940 to 3000 F; SPECTRAY-90, 0.90 microns, range 1320 to 2350 F. A built-in sighting lens enables a unit to be easily aligned and focused on cold targets. Ideal for use with small-diameter targets, the 8886 is especially effective for epitaxial reactors, crystal growing, vacuum-melting and induction furnaces and other narrow sight-tube applications.
For more information See L&N Publication D1.3116-DS

18890-Series Thin-Film Rayotube® Temperature Detectors & Assemblies

For continuous measurement of radiated temperature in many industrial applications, our 18890-Series Rayotubes are highly sensitive, responsive and stable. They are widely used for measuring stationary or moving targets, or with a closed-end "target tube" for temperatures of a furnace atmosphere. Usable at 32 to 212 F ambient temperature without forced cooling, they are available in a choice of ranges from 200 to 5000 F, focal lengths from 4″ to infinity, mountings, sighting- or target-tubes and other options.
For more information See L&N Publication D1.3121-DS

18894/18899 Thin-Film Rayotube® for Glass Temperature

These specialized versions of our 18890-Series Rayotube detectors were developed specifically for glass-industry applications and differ primarily in the optical filters employed. The 18894 measures glass temperature down to a depth of 0.3″; the 18899 measures at the surface. Both models operate continuously with excellent reproducibility that makes them ideal for control applications. Both employ a thin-film thermopile for fast response; time constant 0.015 second. Ambient temperature to 212 F without cooling.
For more information See L&N Publication D1.3122-DS

Instrument Test & Calibration

Expert craftsmanship and meticulous attention to detail go into the manufacture of our widely-used calibration and test equipment. With full NBS traceability, these instruments are in use by thousands of instrument calibration labs and maintenance shops throughout the world. Listed here are brief descriptions of several of the instruments in this group:

9696 CALIBRATOR/TESTER
1985.5F
LEEDS & NORTHRUP INSTRUMENTS

Resistance Standards:

- 4210-B Thomas One-Ohm Standard; Stability 1PPM/Yr.
- 4214-B 10k-Ohm Primary Standard; Stability 3PPM/Yr.
- 422□-B Reichsanstalt-Type Standards; Accuracy ±0.001—±0.05%; 0.1Ω, 0.01Ω, 0.001Ω.
- 40□□-B NBS-Type Resistance Standards; Accuracy ±.003—±0.05%; 0.1Ω, 1.0Ω, 10Ω, 100Ω, 1kΩ, 10kΩ, 100kΩ, 1 megohm.

Portable Test & Calibration Equipment

- 4287 Kelvin Bridge; resolution to 0.01 µohms.
- 4289 Wheatstone Bridge; 1Ω to 11.01 megohms ±0.05%.
- 8064 RTD Bridge; 0-160.1Ω; accuracy ±0.05% or ±0.005.
- 8686 Potentiometer; −10.0 to +100.1 mV; accuracy ±0.03%; has built-in reference junction compensator for TC's.
- 9696 Calibrator/Tester; multi-function electronic instrument; input & output, J, K, T, E, R, S, B Thermocouples, RTD's, mA, mV, VDC; 0.1° resolution for TC's.
- 5430-AM-1 Wheatstone Bridge; classic Type-U test set; has Murray, Varley and Hilborn loop test for cable fault location.

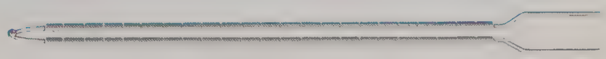
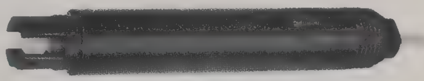
For more information on the products listed here, as well as other L&N instruments for calibration and test, contact your nearest L&N Sales & Service Office or Representative.

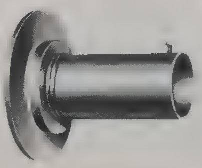
Parts & Supplies

For all your production and maintenance needs, for all L&N products, we maintain substantial stocks of replacement parts, components, accessory equipment and supplies. In addition to factory and warehouse stocks, each L&N Field Office maintains a substantial parts-inventory of key components to support customers served by the office. Among the parts, supplies and accessories we stock in support of L&N instruments and control products are the following:

- **Thermocouple Elements & Parts**—Available is an extensive stock of thermocouple and extension wires and elements, insulators, metal and ceramic protection tubes, heads, mounting fittings, quick-disconnects, switches and terminal boxes.
- **Liquid Analytical Parts & Accessories**—Whether you need an original accessory or a replacement part, you'll find it at L&N. We have wide selections of pH measuring and reference electrodes, MEREDIAN *Combination* electrodes with integral temperature compensation, conductivity cells, mountings . . . and more.
- **Instrument Replacement Parts**—Included are P.C. boards, servo motors, relays, gears, gaskets, and similar electrical and mechanical components and sub-assemblies that are subject to severe wear and physical damage.
- **Recorder Scales, Charts & Markers**—We offer more than 50,000 different chart and scale calibrations; dimensionally accurate and stable chart-paper; replacement or retrofitted disposable ink-markers and thermal marking systems.

For pricing and delivery information on all L&N parts and related equipment, contact your nearest L&N Sales & Service Office or Representative.

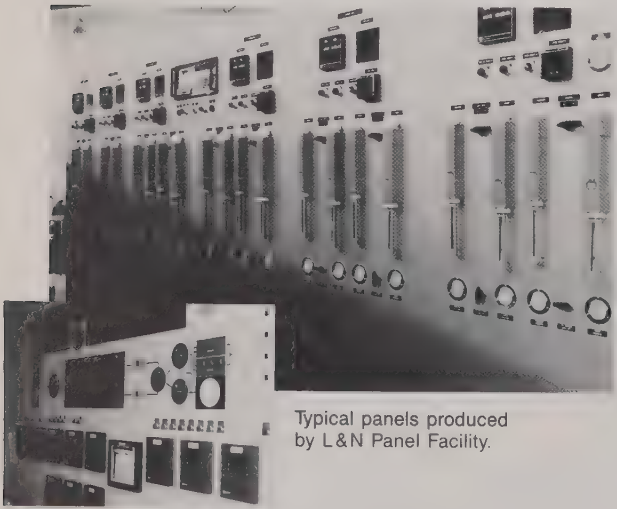





Custom Tailored Service

Because each customer's requirements for service differ, Leeds & Northrup offers a menu of services from which to select:

- **V.A.S. Agreement** We assume total maintenance responsibility for all specified equipment at your facility, including periodic preventative maintenance, emergency service and critical replacement parts stocking.
- **Private Label Services for OEMs and Manufacturers Representatives.** L&N offers 3rd-party "private label" field services to OEMs and Manufacturers Reps which can include assistance with installation and startup at the customer's plant. A maintenance/service agreement extending over the life of the equipment can be included .
- **Pay-As-You-Go Agreement** An on-site preventive maintenance and repair agreement is available. Service is provided on a scheduled basis, and both routine and emergency calls are discounted by a percentage determined by the number of hours scheduled.
- **Fixed Fee Service** Designated equipment is maintained on-site for a fixed yearly cost which includes parts and labor.
- **Guaranteed Price Commissioning Program** Startup assistance (or commissioning service) is available to assure that equipment is properly installed, connected, adjusted and placed in service. Drawings and documentation programs and a panel fabrication program are also available.
- **Warranties and Extended Warranties** All L&N equipment is warranted to meet published specifications. Warranties remain in effect for the specified period, but where desired, extensions of original warranties can be negotiated for specific periods.
- **National Contracts** All your facilities throughout the country can be covered under a single blanket agreement.
- **Bench Repairs** At each of its Field Offices, L&N maintains a bench-repair operation. Here, L&N service personnel repair, upgrade, or refurbish L&N instruments for area customers. When your equipment has to "go to the shop," these facilities offer quick turnaround at reasonable cost.



Typical panels produced by L&N Panel Facility.

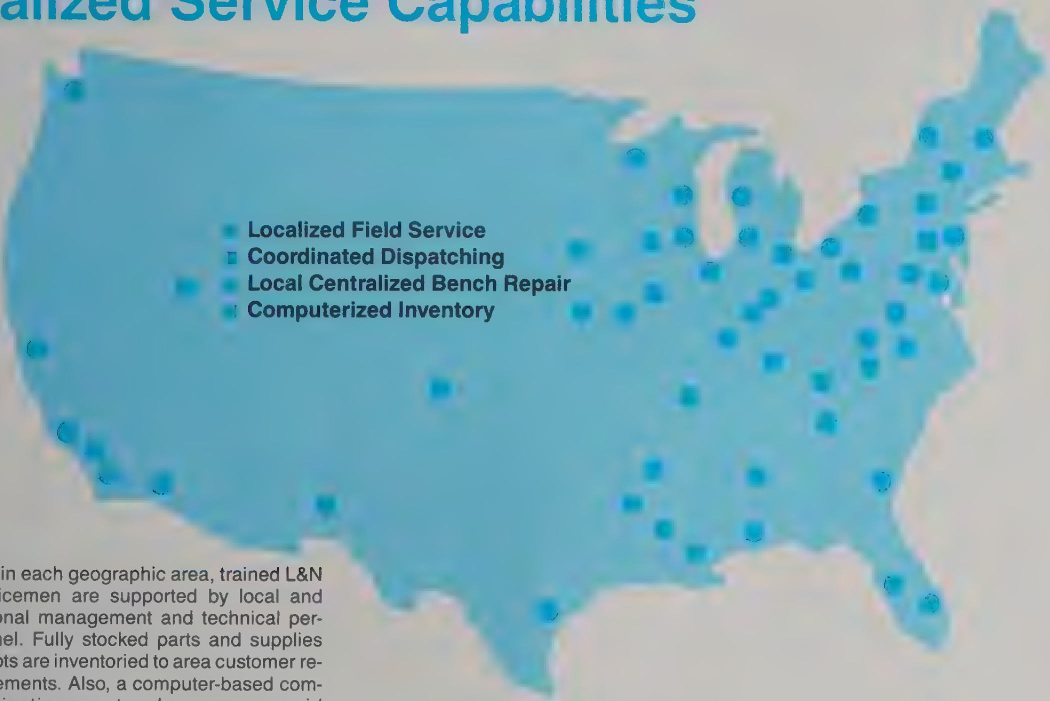
L&N's Panel Facility can build an instrument panel to your exact specifications. Working from your dimension requirements and circuit drawings, we will fabricate the steel panel with all appropriate cutouts and fixtures, mount and wire all equipment to terminal boards, complete with pushbuttons, switches, lights, annunciators, etc. You receive a completely finished panel, fully tested and calibrated, ready for operation

A wide range of maintenance programs and services are available to L&N system users. Included are installation and startup assistance, field service agreements, repair and calibration services, centralized parts and equipment programs, training courses, telephone support, configuration and loop-drawing services, and others.

- **Subscription Service** Under this program, your equipment is updated to reflect any new revisions or improvements made subsequent to your acquiring it. Included is a quarterly newsletter summarizing changes, enhancements and general information on your equipment.
- **Furnace Uniformity Service** Furnace uniformity surveys undertaken by L&N require none of your valuable manpower resources. It includes spreadsheet generation for rapid data analysis. (Spreadsheets are customized to meet your specifications).
- **Calibration Service** Factory-level calibration of your precision and semi-precision resistance standards, measuring instruments and sensors can be performed with standards directly traceable to the National Bureau of Standards.
- **Other Services** available from Leeds & Northrup include:

Plant Outage Support
Telephone Consultation Services
ETN (Equivalent-to-New) Instrument
  Replacement Programs
Spare Parts Kits Stocking Program
Centralized Inventory Programs
Area Service Coordinator Program
Panel Fabrication Program

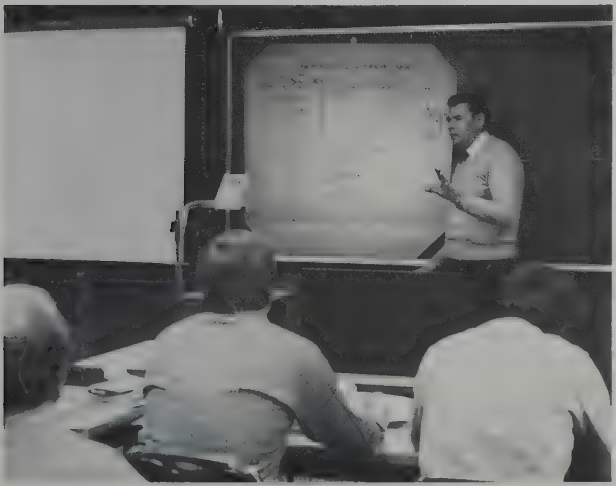
Localized Service Capabilities


● Localized Field Service
● Coordinated Dispatching
● Local Centralized Bench Repair
● Computerized Inventory

Within each geographic area, trained L&N servicemen are supported by local and national management and technical personnel. Fully stocked parts and supplies depots are inventoried to area customer requirements. Also, a computer-based communications network assures rapid processing of customer requirements and service schedules.

Customer Training Facilities

The L&N Training Center offers instruction in the operation, maintenance, calibration and trouble-shooting of L&N products and systems. Your employees can . . .



The Process Control Laboratory at the L&N Training Center has been designed to simulate process operating conditions. Here, process parameters are tailored to closely resemble the processes at students' plants. Tuning adjustments to instruments measuring temperature, pressure, flow, level and water quality are made to realistically reflect actual plant conditions and reactions.

- Improve their job proficiency.
- Contribute to greater plant productivity.
- Help improve product quality.
- Earn Continuing Eduation Units (CEUs).

General courses are offered in:

- Basic Instrument Electronics
- Digital Logic
- Microprocessor Technology
- Water Quality Analysis — Steam Power Applications
- Water Quality Analysis — Waste Treatment Applications
- Process Control — Temperature, Pressure, Level, Flow
- Process Control — pH, ORP, Conductivity

Courses are also conducted for specific instruments and systems (e.g., MICROMAX Loop/Logic Control and Data Acquisition, Combustion Control, MAX 1 Distributed Control System, ELECTROMAX V^{PLUS} Controllers, LN700 Distributed SCADA Systems, C300 and C3000 RTUs, etc.)

Training programs can be custom designed to fit your specific requirements. Courses are conducted at several locations:

- Regularly scheduled classes at the L&N Training Center in North Wales, PA.
- Specially scheduled classes and seminars at motel conference rooms throughout the country.
- Individually scheduled classes on-site at a customer's facility.
- Individually scheduled classes at the L&N Training Center for a specific customer.

For a free consultation to discuss a custom program, or for a detailed proposal and quotation, contact the Area Service Manager at your nearest L&N Field Office.

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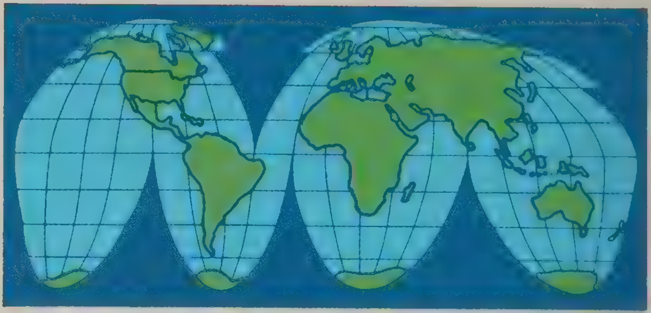

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LEEDS & NORTHRUP
A UNIT OF GENERAL SIGNAL

Instrument & System Solutions!

HEADQUARTERS: Sumneytown Pike, North Wales, PA 19454 USA
PHONE (215) 643-2000 • TELEX 170101 • FAX (215) 699-3702

C0.6216-DS

SPEEDOMAX 100 SERIES
MINIATURE RECORDERS

LEEDS & NORTHRUP
LEEDS & NORTHRUP
LEEDS & NORTHRUP INSTRUMENTS

The Speedomax 100 Series Miniature Recorders are ideal instruments for indicating and recording a variety of variables in research labs and pilot plants, in electric power generation and in numerous processing industries, such as chemical, cement, metals, plastics, etc. Wherever reliable recording is needed and space is at a premium, the Speedomax 100 Series Miniature Recorders are the answer. These recorders have easy-to-read, easy-to-understand displays which clearly show the status of variables, even at a distance, so that process trends can be readily recognized. These miniature recorders offer most of the same features found in larger instruments.

Some of the variables which can be recorded (with alarms, if desired) include direct inputs such as temperature, volts, millivolts, current and electrolytic conductivity. Also, many indirect measurements, such as pressure, flow, pH, redox, percent oxygen, wind direction and velocity, etc., may be recorded from various transducers. Since the recorder can be provided with one-, two-, or three independent channels with different types of inputs, there is enough flexibility to handle almost any recording requirement.

The Speedomax Miniature Recorders are designed for hard use, but easy servicing. The rugged die-cast aluminum in the construction of the door and mainframe offer great durability and stability. Protective covers over circuits and mechanisms help them to operate reliably in demanding environments. Exposed electrical contacts are gold plated to withstand the corrosive effects of harsh environments. However, when maintenance and servicing are required, the modular design of the recorders makes it a quick and easy task. The recorder chassis slides out for easy access, permitting fast loading of charts and snap-in loading of markers. The recorder will continue to function while partially withdrawn to permit adjustments to be made without interrupting operation.

The unique servo assembly and amplifier have been engineered to embody a high degree of accuracy, exceptional reliability and extended service life in a single, compact package. The design couples a precision dc motor to permanently lubricated drive gears and features a permanently lubricated, conductive plastic slidewire in an enclosed module. Mechanical end stops are built into the servo module and the amplifier includes electronic offscale protection.

Long-life disposable markers provide sharp and bright records which are readily distinguishable at a distance. Vivid red, blue and green traces are easily identified even when the variables are closely grouped. These markers snap into the pen carriages, bring a fresh ink supply and a new writing tip with each change. They work in virtually any environment and are not subject to electronic failure or "burnout."

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Instrument & System Solutions!

SPEEDOMAX 100 VERTICAL SCALE RECORDER

Specifications

Speedomax 100 Series vertical scale strip chart recorders meet or exceed performance requirements of ANSI C39.4-1966 and safety requirements of OSHA and ANSI C39.5-1974.

Models One, two or three pen strips chart recorders, wide and narrow chassis type, either self-cased or for Centry shelf mounting.

Type Automatic null balancing recorder. Current is supplied from ac line, reference voltage is Zener regulated.

Measuring Circuit DC potentiometric and voltage dividers. Instrument is provided with electronic end stops to limit off-scale travel in the event of an over-range (or under-range) signal.

High Level EMF Circuit—Span continuously adjustable from 0.1 V to 10 V (100 V with divider on input terminal board). Zero continuously adjustable from −100% to 125% of any span.

Full Range Circuits (include range card and preamplifier)

Millivolts—1 mV to 1000 mV

DC Volts—up to 100 V with range card divider

Thermocouple—Ranges available for standard ISA thermocouple types. Reference junction compensation is automatic.

Electrolytic Conductivity—INF-100 ohm to INF-20 k ohm or 100 ohm span minimum.

Resistance Thermometers—Spans from 2 to 500 ohms using a constant current measuring technique. Three-wire type only, grounded or ungrounded.

pH, Redox—Direct input from preamplifier type electrode assemblies.

Gain and Damping Adjustments Automatic for all spans and response times.

Maximum Source Impedance High level circuit, 2500 ohms. Full range circuit, 10,000 ohms.

Input Impedance *High Level Circuit, 2 megohms at balance:* for 0.1 V to 5 V span; 20 k ohms/internal divider for 5 to 10 V span; 5 k ohm/V divider on terminal board for 10 to 100 V *Full Range Circuit, 5 megohms at balance* for 1 mV to 1 V span; 5 k ohm/V divider for 1 V to 100 V span.

Accuracy High level circuits ±0.5%. ±1.0% for spans less than 500 mV.

Full range circuits ±0.5% ±2 microvolts. For Suppression Rate (SR) greater than 2 add 0.1 (SR-2)%. For thermocouple circuits add ±1/2°C. For RTD circuits add 0.1% × SR.

Deadband 0.25% of span.

Span-Step-Response Time Rating Adjustable 1 to 10 seconds. Factory set at 5 seconds nominal.

Chart Standard chart paper for ink marking. 15.5 m or 17 yards long.

Chart Drive 1, 2 or 14 speeds. On/Off and Speed Select Switches are standard features.

Chart Speeds From 1 cm/hr to 720 cm/hr (at 2 cm/hr, chart lasts 1 month minimum).

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A UNIT OF GENERAL SIGNAL

Marking System Disposable markers, Pen 1—Red, Pen 2—Blue, Pen 3—Green.

Ambient Temperature Limits *Rated Operating:* 15 to 40° C (59 to 104° F); *Extreme Operating:* −9 to +50° C (15.8 to 122° F).

Relative Humidity 10 to 90%.

Alarms Up to 2 per channel.

Alarm Contact Rating Alarm circuits rated at 120 V ac, 2 amperes, resistive load.

Common Mode Rejection At power line frequency, 80 dB or 100 V, whichever is less for full range circuits. 60 dB or 100 V, whichever is less for high level circuits.

Normal Mode Rejection Full range circuits, equal to or greater than 60 dB at power line frequency and above. 40 dB (50 Hz and above) for high level circuits.

Dimensions:

Case	Narrow	Wide
Width	65 mm (2.5″)	136 mm (5.3″)
Flange	78 mm (3.0″)	150 mm (5.9″)
Height	136 mm (5.3″)	136 mm (5.3″)
Flange	150 mm (5.9″)	150 mm (5.9″)
Length	607 mm (23.9″)	347 or 431 mm (13.7″ or 17″)
Door	**Narrow**	**Wide**
Width	72 mm (2.8″)	144 mm (5.7″)
Height	144 mm (5.7″)	144 mm (5.7″)
Thickness	15 mm (0.6″)	15 mm (0.6″)

Power Requirements 120 V, 50/60 Hz; 220 or 240 V, 50 Hz; or 24 V dc. On/Off Power Switch is standard feature.

VA Rating of Basic Recorders (volt-amp)

	Self-Cased	Centry (24 V dc)
1 pen	11 VA max.	12 VA (0.21 A)
2 pen	19 VA max.	21 VA (0.42 A)
3 pen	27 VA max.	30 VA (0.63 A)

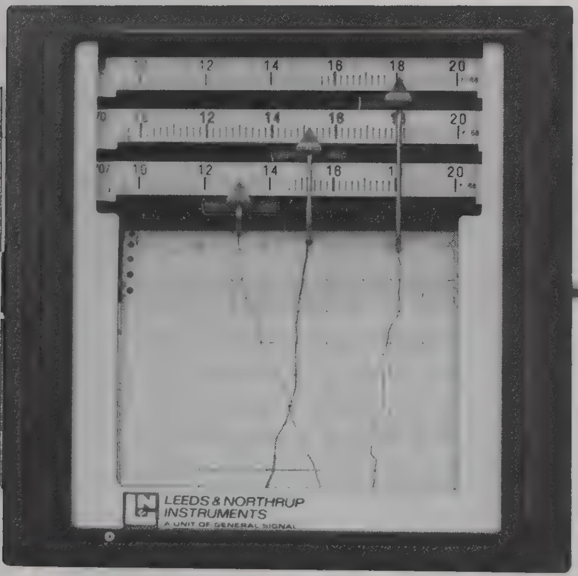
NOTE: Recorder power is fused.

Weight Approximately 14 to 17 lb. (6.3 to 7.7 kg), depending on model type and options.

Color Black door and case flange (front). Case behind front flange is natural sheet metal.

Warranty 24 months.

SPEEDOMAX 100
HORIZONTAL SCALE RECORDER



Specifications

Speedomax 100 Series horizontal scale strip chart recorders meet or exceed performance requirements of ANSI C39.4-1966 and safety requirements of OSHA and ANSI C39.5-1974.

Models One, two or three pen strip chart recorders, horizontal scale type.

Type Automatic null balancing recorder. Current is supplied from ac line, reference voltage is Zener regulated.

Measuring Circuit DC potentiometric and voltage dividers. Instrument is provided with electronic end stops to limit off-scale travel in the event of an over-range (or under-range) signal.

High Level EMF Circuit—Span continuously adjustable from 0.1 V to 10 V (100 V with divider on input terminal board). Zero continuously adjustable from −100% to 125% of any span.

Full Range Circuits (include range card and preamplifier)

Millivolts—1 mV to 1000 mV
DC Volts—up to 100 V with range card divider

Thermocouple—Ranges available for standard ISA thermocouple types. Reference junction compensation is automatic.

Electrolytic Conductivity—INF-100 ohm to INF-20 k ohm or 100 ohm span minimum.

Resistance Thermometers—Spans from 2 to 500 ohms using a constant current measuring technique. Three-wire type only, grounded or ungrounded.

Gain and Damping Adjustments Automatic for all spans and response times.

Maximum Source Impedance High level circuit, 2500 ohms. Full range circuit, 10,000 ohms.

Input Impedance *High Level Circuit, 2 megohms at balance:* for 0.1 V to 5 V span; 20 k ohms/internal divider for 5 to 10 V span; 5 k ohm/V divider on terminal board for 10 to 100 V.

Full Range Circuit, 5 megohms at balance for 1 mV to 1 V span; 5 k ohm/V divider for 1 V to 100 V span.

Accuracy High level circuits ±0.5%. ±1.0% for spans less than 500 mV.

Full range circuits ±0.5% ±2 microvolts. For Suppression Rate (SR) greater than 2 add 0.1 (SR-2)%. For thermocouple circuits add ±1/2°C. For RTD circuits add 0.1% × SR.
Deadband 0.25% of span.

Span-Step-Response Time Rating Adjustable 1 to 10 seconds. Factory set at 5 seconds nominal.

Chart Standard chart paper for ink marking, 15.5 m or 17 yards long.

Chart Drive 1 or 2 speeds. On/Off Switch is standard feature.

Chart Speeds From 1 cm/hr to 360 cm/hr.

Marking System Disposable markers, Pen 1—Red, Pen 2—Blue, Pen 3—Green.

Ambient Temperature Limits *Rated Operating:* 15 to 40° C (59 to 104° F); *Extreme Operating:* −9 to +50° C (15.8 to 122° F).

Relative Humidity 10 to 90%.

Alarms Up to 2 per channel.

Alarm Contact Rating Alarm circuits rated at 120 V ac, 2 amperes, resistive load.

Common Mode Rejection At power line frequency, 80 dB or 100 V, whichever is less for full range circuits. 60 dB or 100 V, whichever is less for high level circuits.

Normal Mode Rejection Full range circuits, equal to or greater than 60 dB at power line frequency and above. 40 dB (50 Hz and above) for high level circuits.

Dimensions: Metal case is 6″ wide × 6″ high (152 mm × 152 mm) with a front flange 7″ wide × 7″ high (178 mm × 178 mm). For High Level Recorder, case is 14.4″ long (366 mm). For Full Range Circuits, case is 17.4″ long (442 mm).

Power Requirements 120 V, 50/60 Hz; 220 or 240 V, 50 Hz; On/Off Power Switch is standard feature.

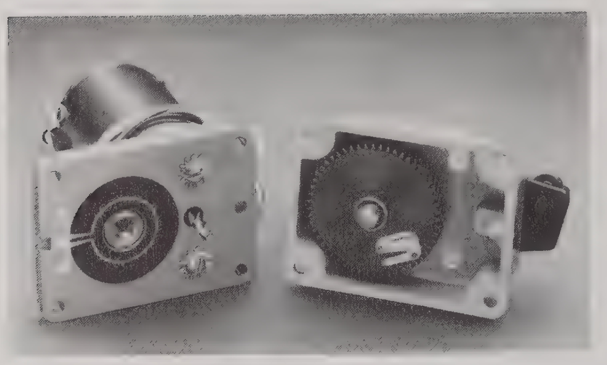
VA Rating of Basic Recorders (volt-amp)

1 pen	11 VA max.
2 pen	19 VA max.
3 pen	27 VA max.

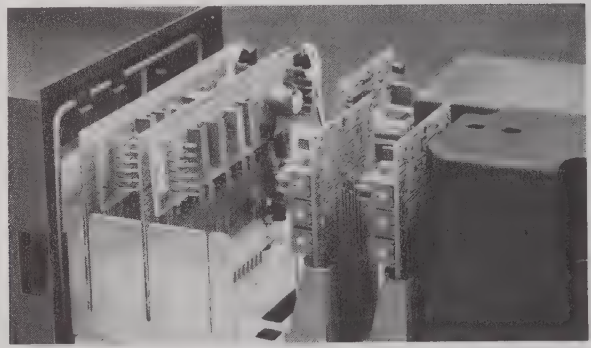
Weight Approximately 14 to 17 lb. (6.3 to 7.7 kg), depending on model type and options.

Color Black door and case flange (front). Case behind front flange is natural sheet metal.

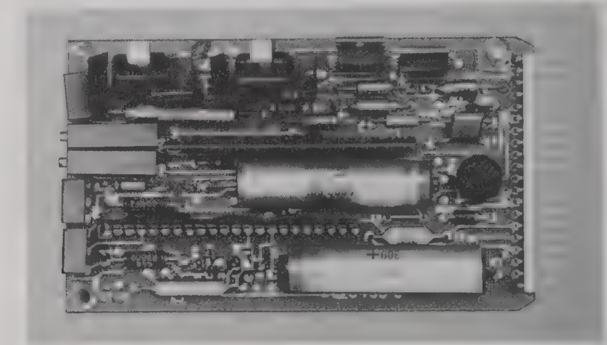
Warranty 24 Months.



The servo assembly is an efficiently designed package incorporating a precision d-c servo motor linked to a lubricated, conductive-plastic slidewire in a single enclosed housing.



Plug-in preamplifier cards with range cards mounted on them gives the Speedomax 100 the flexibility to accept a full range of signals, including volts, millivolts and milliamperes, plus RTD, thermal radiation, thermocouple and conductivity inputs.



Built around 2 custom single inline packages, the servo amplifier which drives the channel amplifier has adjustments for the high-level spans, the zero, and the balancing speed.

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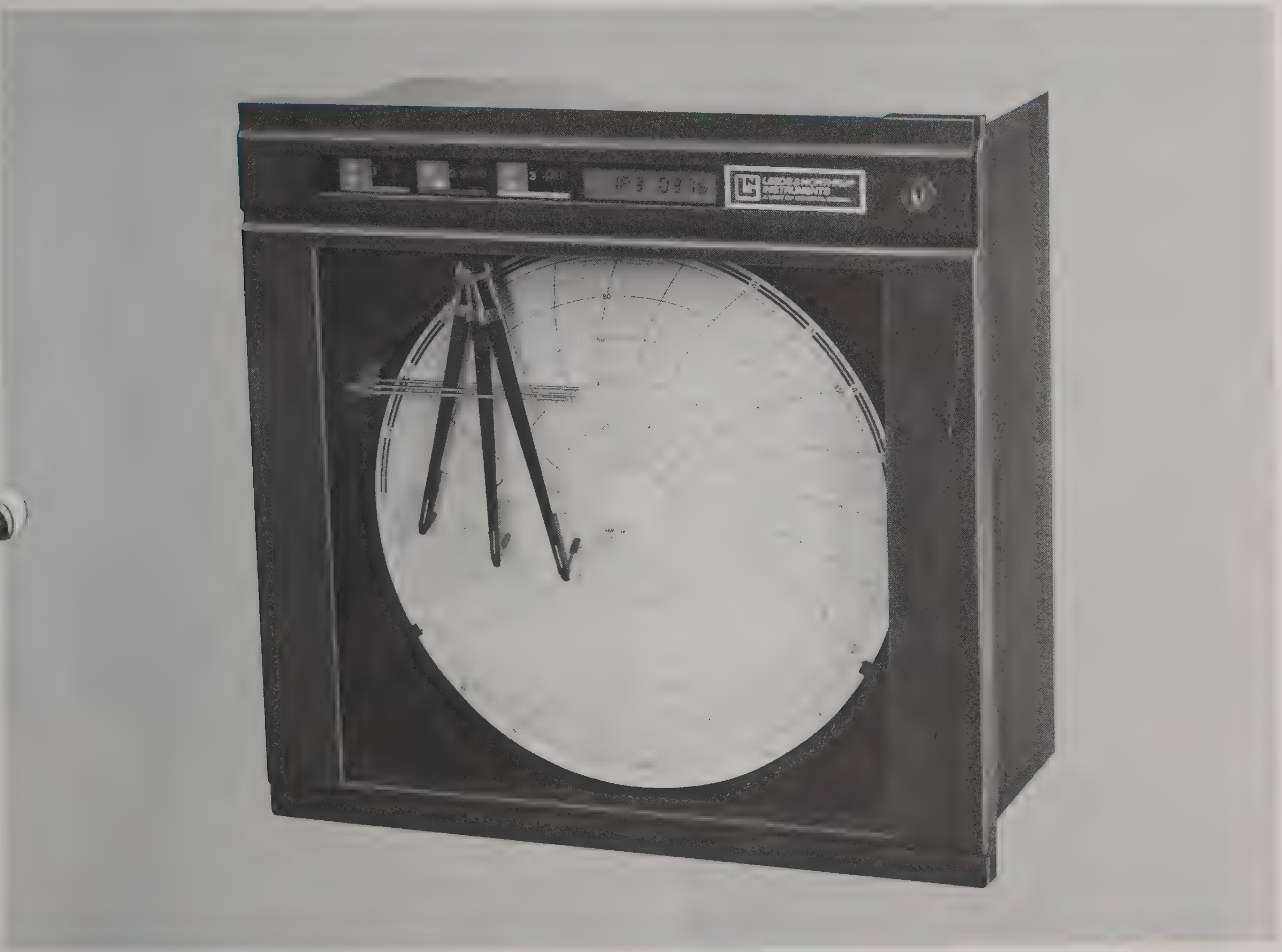
LN200 SERIES 1-,2- & 3-Pen Round-Chart Recorders



- Versatile microprocessor control of input ranging, linearization, alarms, pen movement, displays and control output.
- User-programmable via six membrane switches and simple programming panel accessible from front of instrument.
- Highly accurate stepping motors enhance reliability and resolution.
- Available with 25 V dc power supply to operate up to three two-wire transmitters.
- Available with current retransmission of measured variable.
- Up to three disposable fiber-tip pens with optional ranged input or 3-position event-pen as 3rd channel.
- Large 8-digit LCD display plus individual red and green LED's to indicate alarm state.
- Programmable control relay logic, alarm indication status and PID control options. Chart speed can be set in hourly increments from one hour to seven days.
- Totalizes analog or pulse-frequency flow inputs for recording and retransmission.

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LN200 SERIES 1-,2- & 3-Pen Round-Chart Recorders

The LN200 Series Round-Chart Recorder utilizes state-of-the-art microprocessor technology. It has been specifically designed to provide simple programming via user-friendly controls and engineered to give greater accuracy, improved reliability and reduced servicing.

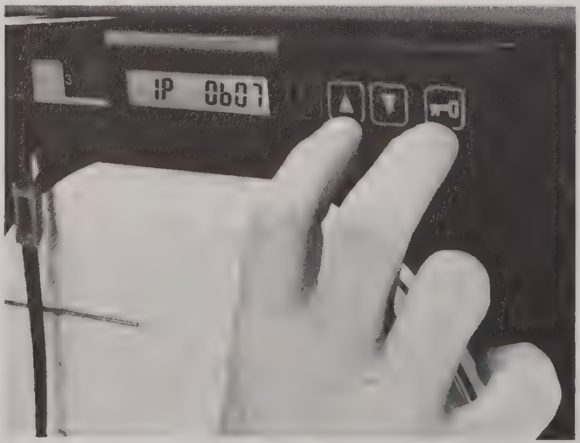
The microprocessor provides versatile control of the input ranging and linearization plus control of the pen drive, lift and referencing, the alarms, the display and the control outputs.

Signals from thermocouples and resistance thermometers are displayed and recorded; also linear and square law current and voltage inputs or other variables that can be converted to an acceptable voltage or current level.

The recorder is available in one-, two- and three-channel versions with up to two set points and two relays per channel for alarm or on/off control. One- and two-pen recorders can be supplied with an additional pen acting as an event marker on the outer edge of the chart. A 25 V dc power supply is available to operate up to three two-wire transmitters.

Additional options for Channel 1 include a retransmission output, time proportioning or analog PID control.

Changes to instrument operation can be easily programmed by means of touch-sensitive membrane switches located on the control panel above the chart, behind a lockable door.



"Security" switch (right), pressed simultaneously with "Up" or "Down" switches, prevents accidental alteration of set-point or range values. "Scroll" switch selects any input or set-point value for continuous display or starts sequential display of all items.

Identical stepper motors are mounted on a steel chassis to assure temperature stability.

Automatic optical indexing facility enables pens to be referenced every time a chart is changed.

Programming chart is clear, simple and easy to follow. Every stage of setting up the instrument is described in precise, logical steps.

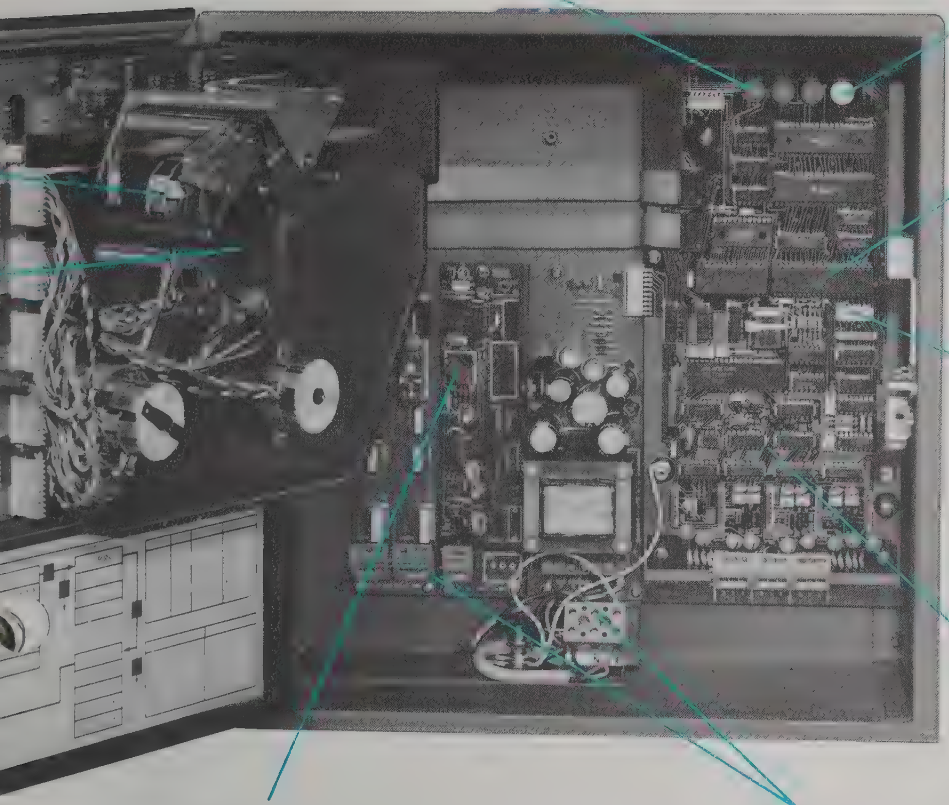
Rugged, foam-gasketed lockable door.

Display and Controls

In normal operation, an 8-digit liquid crystal display above the chart indicates the input and set-point values for each channel. A "Scroll" switch next to the display selects any item for continuous display. Alternatively, these values for each channel can be displayed in automatic sequence. The set-point values can be altered by means of "Up" and "Down" switches which can only by operated in conjunction with a "Security" switch to prevent accidental operation.

Alarm state is indicated by a red/green LED pair for each set point. These are programmed to indicate the desired color when the input signal is above or below the set point. The associated relays can be programmed to be either energized or de-energized in the alarm condition in on/off, latching, or neutral-zone (on or off).

Two additional membrane switches are provided to raise or lower the pens when changing a chart.



Channel buttons, pen-color-coded for easy recognition, select the appropriate channel input scroll with the first push and then select different internal scrolls (display, output, calibrate) on subsequent pushes. They are an integral part of the programming procedure and, along with the front-panel-mounted access key switch, provide security against accidental or unauthorized changes to the stored data.

Decimal point button for programming the input range information and the display range.

The microprocessor incorporates an on-chip serial port to transfer data both to LCD and LEDs. It has a very flexible and powerful instruction set.

Non-volatile memory avoids the need for a battery powered RAM when the unit is turned off. Memory is accessed only when the unit is turned on or when there is a change in the parameters. This technique prevents loss of data for typically ten years during power down conditions. (Note: Flow versions have battery back up to memory.)

Software controlled amplifier accepts characterized analog input signals. Amplifier gain is determined by the range values set by the user.

The control output relays can be energized in a wide variety of configurations. Other input/output modules mounted in this area can provide retransmission, analog control, transmitter power supply or flow signal conditioning.

User terminal connections.

Flow Options

The LN200 is available for flow indications and recording with totalization on one or two channels. Input signals can be linear or square law analog or of the pulse frequency type. Any analog flow input channel may be changed from a totalizer to a standard version to accept analog signals for other measurements simply by turning the flow total off.

Each flow channel has two totalizers, one of which can be used for a batch total displayed on the 8-digit LCD within the operating page and resettable on the front control panel. The other is used for display of a secure total on the output of the appropriate channel and is accessible only by operating the internal channel-select buttons.

Both totals are protected in the memory for up to ten years in the event of power failure.

For applications requiring a remote counter, a relay module with volt-free contacts or an alternative module with 24V d.c. pulsed drive is available.

A filter is incorporated into the flow recorder to reduce the effect of noisy signals. It can be averaged over a 0 to 20 seconds maximum sampling time, programmable in one second steps.

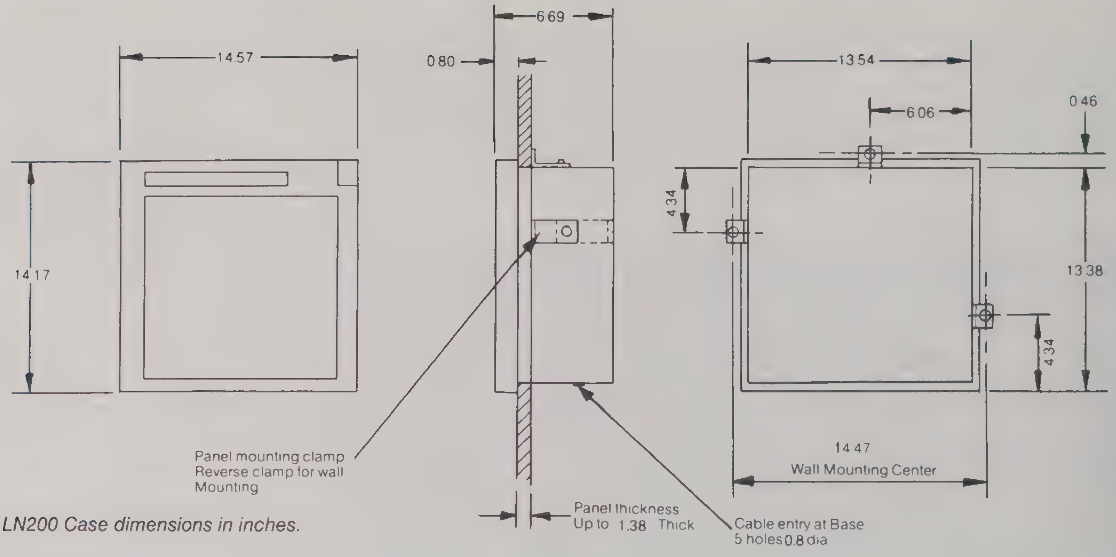
Specifications

Models One-, two- or three-pen round-chart recorders

Type Solid-state microprocessor electronics with digitally controlled electronic amplification of unbalance and a stepper motor to effect balancing action.

Channels One, two or three input channels with 8 volts rms isolation between channels. Channel 3 optional 3-position event pen or ranged input.

(Continued)



LN200 Case dimensions in inches.

Measuring Circuits

DC Volts 20V maximum; 0.5 minimum span.
Millivolts 1000 mV maximum; 5 mV minimum span.
Current 100 mA maximum; 0.5 mA minimum.
Frequency 0-4.0 kHz maximum; 0-0.1 Hz minimum.

Thermocouples Automatic reference junction compensation; ranges programmable within the following limits:

Type E −40 to 1830 F (−40 to 1000 C); min. span 150 F (85 C).

Type J −140 to 1650 F (−100 to 900 C); min. span 180 F (100 C).

Type K 0 to 2370 F (−15 to 1300 C); min. span 270 F (150 C).

Type R & S 0 to 3090 F (−15 to 1700 C); min. span 1100 F (600 C).

Type T −400 to 570 F (−250 to 300 C); min. span 220 F (120 C) for ranges starting above 0. Min. span 310 F (170 C) for ranges starting below 0.

RTD 100 ohms Pt. −320 to 1110 F (−200 to 600 C); min. span 90 F (50 C). L&N Calibration (0.000385 ohm/ohm/°C).

Input Impedance

Millivolt Inputs >10 megohms.

Voltage Inputs 10,000 ohms.

Current Inputs 10 ohms.

Interference Rejection (Based on 0 to 1 V range).

Common Mode <1% span error max. for 250 V r.m.s. 50 Hz.

Normal Mode <1% span error for 200% span, 50 Hz.

Radio Frequency Interference <±2% f.s.d. deviation over range 27 MHz to 500 MHz at a field strength of 10 V/meter.

Accuracy ±0.25% span maximum.

Span-Step-Response-Time 6 seconds for 0-100% typical. Input signals for flow options can be averaged over 0-20 seconds maximum sample (filter) time adjustable in 1-second steps without reduction in minimum response time.

Chart Circular with linear graduations.

Chart Speed From 1 revolution per hour up to 1 revolution per week (168 hours), adjustable in 1-hour steps.

Marking System Disposable markers; Pen 1, red; Pen 2, green; Pen 3, blue.

Ambient Temperature Limits 32 to 130 F (0 to 55 C).

Relative Humidity Limits 0 to 80% R.H. (Non-condensing).

Set Points Up to 2 per channel; on/off, latching or 3-state.

Outputs Single-pole relay; analog retransmission (4-20 mA, isolated from input); analog or duration-adjusting (relay output) control; flow totalization (1- or 2-pen only).

Alarm Contact Rating

Voltage 250 V ac; 250 V dc maximum.

Current 5 A ac; 5 A dc maximum.

Loading 1250 VA; 50 W maximum.

Time Proportioning Control (D.A.T.)
Available on Pen 1 with PID functions. Cycle time adjustable from 5 to 60 seconds in 1 second steps.

Analog Output Control (C.A.T.)
Available on Pen 1 with PID functions. Outputs up to 20 mA dc at 15V.

Control Functions

Proportional Band 2 to 500% in 1% steps.

Integral Action Time 1 to 1800 secs. in 1 sec. steps + off.

Deviation Action Time 0 to 600 secs. in 1 sec. steps + off.

Approach Band 0.1 to 3.0 proportional bands in 0.1 steps.

Case Sheet metal case with hinged chart plate. Lockable foam molded door (14.57″W × 14.17″H) with polycarbonate window. Cutout dimensions 13.6″W × 13.46″H, depth from panel face is 5.91″. Can be wall or panel mounted.

Case and Door Color Black.

Enclosure Classification Rated NEMA 3.

Power Requirements 110 or 230V, 50 or 60 Hz; 20 VA maximum.

Weight Approximately 23 lbs.

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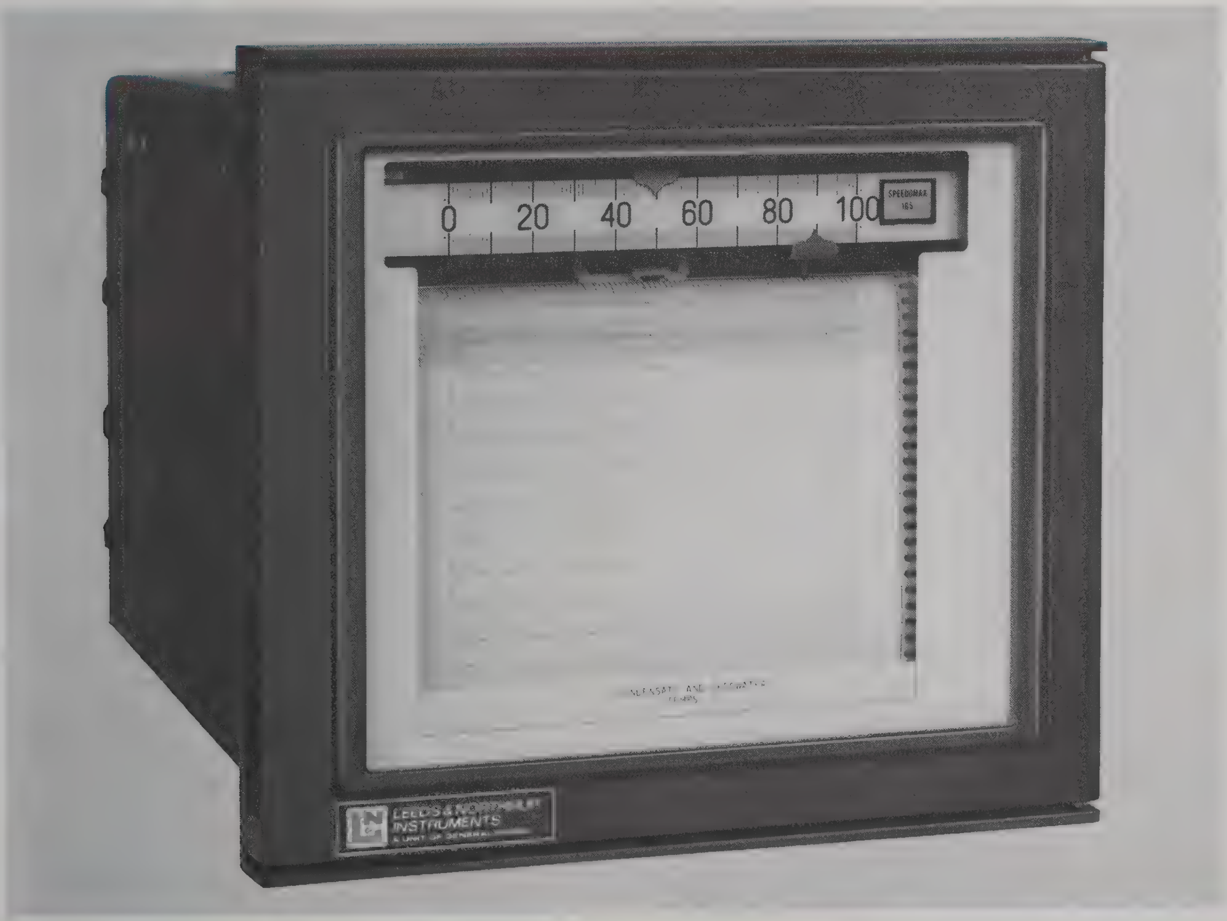
SPEEDOMAX® 165 & 250 SERIES ONE-PEN & TWO-PEN RECORDERS



- **Two sizes available. Wide-scale, wide-chart Speedomax 250 has 250 mm calibrated chart width; intermediate size Speedomax 165 has 165 mm calibrated strip chart.**
- **Automatic gain and damping for all spans and response times.**
- **Up to 3 ranges on the red pen; 1 range on the blue pen. Multi-range capability includes electrolytic conductivity, pH and Redox ranges.**
- **Separate chart motors allow wide choice of chart speeds. Up to 5 motors on Speedomax 250; up to 3 on Speedomax 165.**
- **Up to 8 alarms available on a recorder. Assignable in any combination to either pen on a two-pen recorder.**
- **Enclosed conductive plastic slidewire is virtually maintenance free.**
- **Electronic end stops and open circuit indication.**
- **Long-life disposable markers standard . . . thermal marking available as option.**
- **Swing-out paper loading for easy chart change; markers snap in for quick replacement.**

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SPEEDOMAX® 165 & 250 SERIES ONE-PEN & TWO-PEN RECORDERS

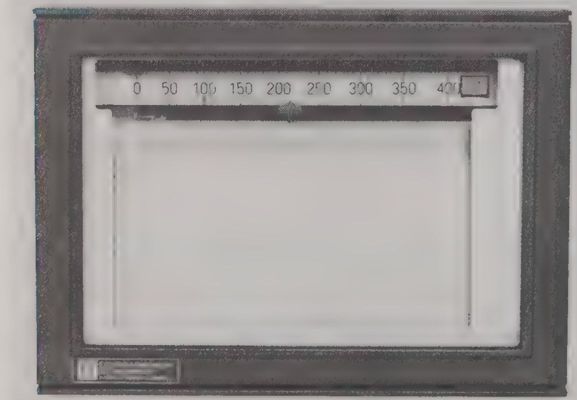
Speedomax 165 and Speedomax 250 Series One-Pen and Two-Pen Strip Chart Recorders offer state-of-the-art techniques for single or dual input recording.

Available in a wide-chart version with a 250 mm calibrated chart width, and a smaller version with a 165 mm calibrated chart, both recorders can be supplied with either one or two pens and your choice of an ink or thermal marking system.

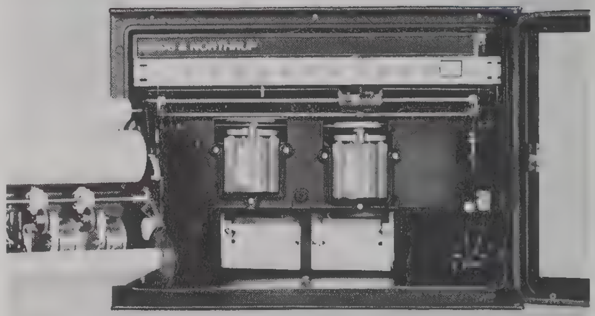
MARKING SYSTEMS The disposable marker features a large ink capacity — about 50% larger than most other markers — for longer recording without interruption. Its snap-in design permits quick and easy replacement when a change is necessary. On two-pen recorders, different color markers are supplied for two-color recording.

The optional thermal marking system uses no ink. A new thermal pen has been developed in conjunction with a thermal chart paper and subjected to exhaustive tests for maximum reliability. There's never a blur and the system never runs dry. The entire system is automatic, and a clear, legible, uniform trace is maintained on the chart record without any adjustments required to compensate for changes in the slew rate.

NOTEWORTHY FEATURES Up to three ranges are available for the red pen, including electrolytic conductivity, pH and Redox ranges. One range is available for the blue pen. Individual chart motors provide a choice of chart speeds in any desired combination. Model 250 is available with up to five different motors, the 165 with up to three — and all are switch selectable. Up to eight alarms can be obtained with a recorder, and with a two-pen recorder, they can be assigned in any combination to the pens.



The Speedomax 165/250 Series One-Pen and Two-Pen Recorders are available in a wide-chart Model 250 (shown above) and a smaller size Model 165 (see cover).



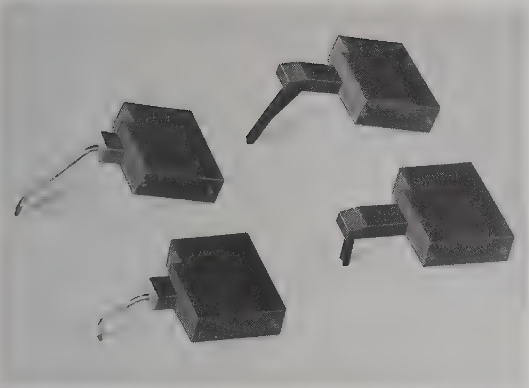
The recorder door swings open a full 180° and the paper drive assembly swings out, allowing ready replacement of charts or pens and easy servicing when required.

All gain and damping adjustments are made automatically as a range is changed and the servo system utilizes an enclosed conductive plastic slidewire which is protected from dust and dirt as well as accidental damage. The main servo amplifier has adjustable electronic end stops to eliminate the drive cord wear and impact damage that often occur with mechanical end stops.

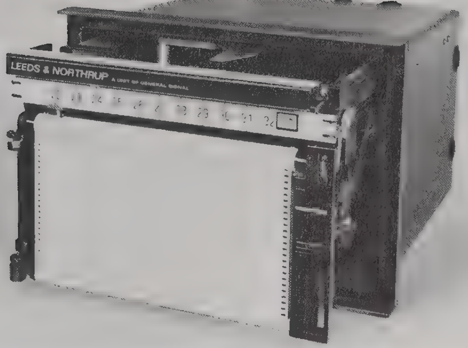
EASY MAINTENANCE, SERVICING The Speedomax 165 and 250 Recorders utilize rugged die-cast aluminum in the construction of the door, case and mainframe, and are built to operate reliably in all types of environments. However, when maintenance and servicing are required, the design of the recorders makes it a quick and easy task. In addition to the snap-in loading of charts and markers, the recorder features a door which can be removed easily in seconds — without tools. This permits ready access to the interior, which has plenty of space in which to work

The entire internal chassis slides out for ease of servicing (if necessary, it can be lifted out for bench servicing). The paper drive swings out to allow rapid loading of the paper and easy access to the internal circuitry.

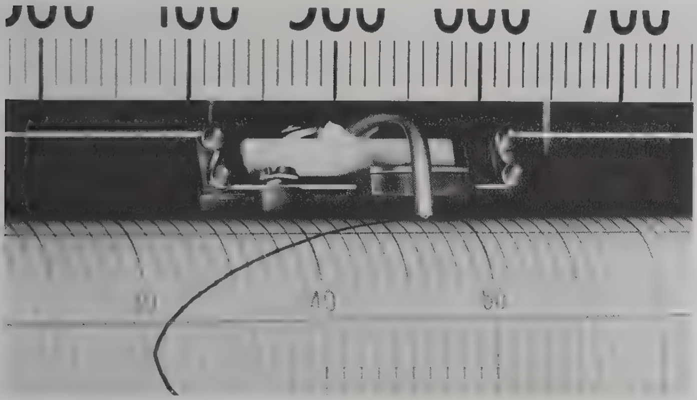
Over 90% of all parts are common to both the Speedomax 165 and 250 one-pen and two-pen recorders. This can substantially reduce the inventory of spare parts required.



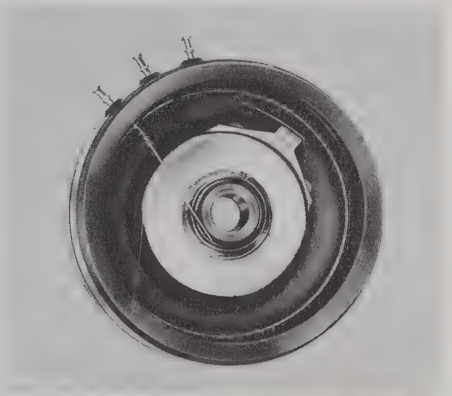
Large capacity disposable markers assure uninterrupted recording for longer periods.



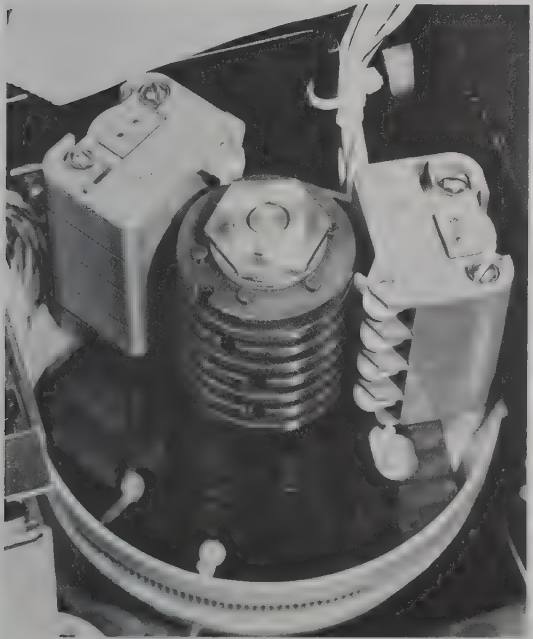
Slide-out Chassis offers exceptional accessibility to instrument components (chassis lifts off tracks for servicing).



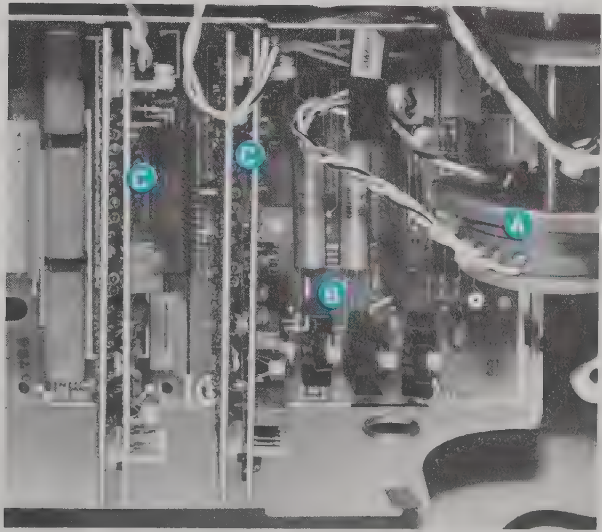
Optional thermal pen produces a clean and uniform trace regardless of chart speed or slew rate.



Long wearing conductive plastic slidewire is enclosed for protection against dust and dirt.



Up to 8 alarms are available with either the one-pen or two-pen model of the Speedomax 165 or 250 recorder. The alarm switches are mounted on the servo stack where they are readily accessible.



Preamplifier, Range Card and Servo Amplifier Module. To the left of the slidewire (A) are mounted the Servo Amplifier Module (B), and the range card riding piggyback on the preamplifier card (C). These cards plug in for fast and easy range change and servicing The Amplifier has plug-in resistor for convenience in changing the balancing time in the field Balancing time may be varied from 1 to 10 seconds to provide additional filtering for noisy signals

Specifications

Speedomax 165 and 250 Series One-Pen and Two-Pen Strip Chart Recorders meet or exceed performance requirements of ANSI C39.4-1966 and safety requirements of ANSI S82.01-1988 and OSHA.

Models	Speedomax 165 Series One- and Two-Pen Strip Chart Recorder Speedomax 250 Series One- and Two-Pen Strip Chart Recorder
Type	Automatic null-balancing recorder. Employs solid-state electronic amplification of error signal and a reversing dc motor system to effect balance.
Measuring Circuit	DC potentiometer; voltage dividers used on spans above 1000 mV
Measuring Circuit Current Source	Supplied by ac line, rectified and regulated by Zener diode circuit
High Level EMF Circuit	Span continuously adjustable from 0.1 V to 10 V. Zero continuously adjustable from −100% to 125% of span.

Preamplifier and Range Card Circuits

Inputs	Minimum Span	Maximum Span
DC millivolts	1 mV	1000 mV
DC volts (by divider)	1 V	100 V
Thermocouple	Ranges available for standard ISA thermocouple types. Reference junction compensation is automatic.	
Resistance thermometers	Spans from 2 to 500 ohms using a constant current measuring technique.	
Radiation Detectors	Ranges available for use with 18890 Series Rayotube Detectors, and 8885 or 8886 Series Spectray Detectors.	
Electrolytic Conductivity	Direct measurement from conductivity cells with automatic, manual or fixed compensation.	
pH and Redox	Direct measurement from electrode mountings (with pre-amplifier).	

Indicating Scale	165 Series: 165 mm (6-1/2″ nominal) calibrated length. 250 Series: 250 mm (9-7/8″ nominal) calibrated length.
Impedance	Maximum Source: High Level Circuit......2,500 Ω Preamplifier and Range Card Circuits......10,000 Ω

Accuracy

	Span	Accuracy	Span	Accuracy
High Level EMF Circuit:	1 to 10 V	±0.25	0.3 to 0.4 V	±0.40
	0.5 to 1.0 V	±0.30	0.2 to 0.3 V	±0.45
	0.4 to 0.5 V	±0.35	0.1 to 0.2 V	±0.50

Preamplifier Circuits: ±0.25% of span ±3.0 μV for total recorder with a suppression ratio of 2 or less. ±[0.25 + 0.1 (SR-2)]% of span for suppression ratio greater than 2. Thermocouple Circuits: additional ±1/6°C (±1/3°F). RTD Circuits: additional ±0.1% per step of suppression. Voltage Divider: additional ±0.05%.

Dead Band	0.1% of span
Span Step-Response-Time Rating	5 seconds nominal full scale standard 1 or 10 seconds available
Chart	Standard chart paper for ink marking. Thermal sensitive paper (printed in red) for thermal marking. Time lines available with metric or English spacing. 165 Series: 165 mm (6-½″ nominal) calibrated width. 220 mm (8.7″ nominal) overall. Length is 36.5 meters (40 yd) 250 Series: 250 mm (9⅞″ nominal) calibrated width. 305 mm (12″ nominal) overall. Length is 36.5 meters (40 yd)
Chart Drive	Speedomax 165: 1, 2, or 3 speeds Speedomax 250: 1, 2, 3, 4 or 5 speeds.
Chart Speeds	From ¼″ per hour to 900″ per hour or 2 cm per hour to 2250 cm per hour
Marking System	Available with disposable marker, or optional thermal marker. Also available with optional higher-visibility disposable pens that mark forward on chart for instant recognition of upsets.
Ambient Temperature Limits	RATED OPERATING: 15 C to 40 C (59 F to 104 F). EXTREME OPERATING: −9 C to 50 C (15.8 F to 122 F).
Relative Humidity	10% to 90%.
Alarm Contact Rating	The alarm circuits in the recorder are rated at 120 VAC — 2 amperes, resistive load.
Common Mode Rejection	At power line frequency, 80 dB or 100 volts, whichever is less.
Normal Mode Rejection	At least 60 dB at power line frequency and above.
Power Requirements	120 Volts, 50 or 60 Hz, and 220 or 240 Volts, 50 Hz; 35 VA, 1-Pen; 50 VA, 2-Pen.
Case	165 Series: 13-½″ (343 mm) W × 12-7/32″ (310.4 mm) H × 14-¾″ (374.7 mm) D 250 Series: 16-27/32″ (427.8 mm) W × 12-7/32″ (310.4 mm) H × 14-¾″ (374.7 mm) D.
Weight	165 Series, approximately 42 lb (19 kg) 250 Series, approximately 50 lb (22.6 kg).
Case Color	Black

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WARRANTY

Fully warranted against all defects of materials and workmanship for a period of 24 months from date of installation or 30 months from date of shipment, whichever comes first.

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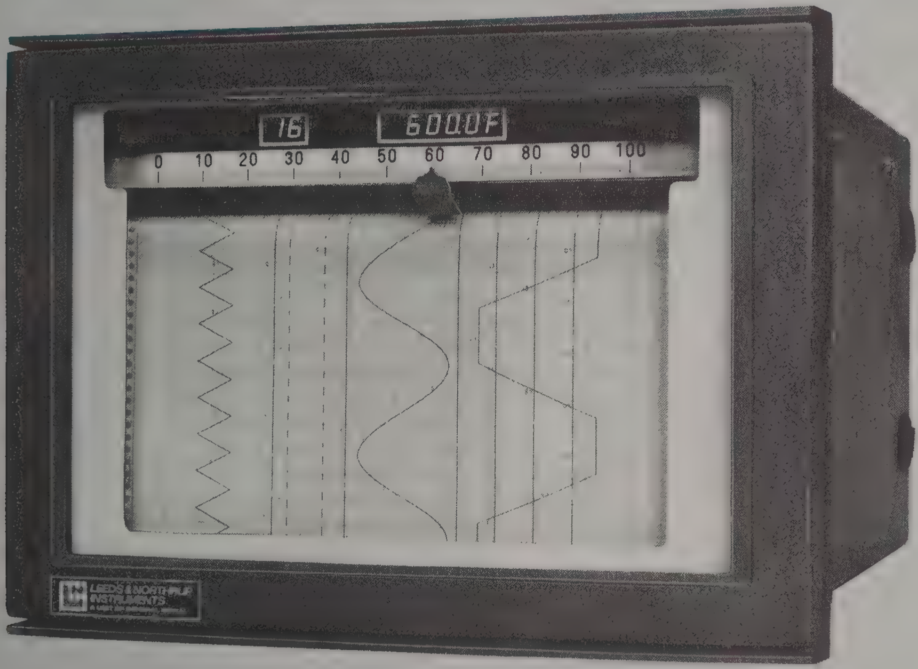
SPEEDOMAX® 1650 & 2500
MULTIPOINT RECORDERS



- 15 point recording capability with Speedomax 1650 and 15- or 30-point with Speedomax 2500—both for emf and thermocouples. 10- or 20-point with Speedomax 2500 RTD for emf, thermocouples and RTDs
- Serial communications capability for all Speedomax models with optional RS422/485 plug-in module for computer interface
- Simple guided programming in plain English to configure ranges and optional alarms on a per-point basis
- Highly versatile alarm capability:
  - Up to four levels of alarm per point
  - Choice of four alarm modes for each level: high or low, and positive or negative rate-of-change
  - Grouping of alarms in "AND" or "OR" logic, to actuate from 2 to 12 relays
  - Printout on chart of point number and time when point goes in and out of alarm
  - Bold LED signal light to indicate alarm condition
  - Selectable speedup of printout and chart speed on alarm
- Large LED display of point number and measured value (to four significant figures)
- Linear or non-linear recording of thermocouples and RTDs inputs, permitting a wide choice of standard charts
- Wide-scale, wide-chart Speedomax 2500, with 250-mm calibrated chart; intermediate-size Speedomax 1650, with 165-mm calibrated chart
- Choice of programmable chart speeds from 1″ to 240″/hr, in 1″/hr increments; two speeds—with manual or automatic transfer—can be programmed
- All programmed data protected from unauthorized change by security code, and from loss of power by non-volatile memory; real-time clock is backed up for 500 hours by rechargeable batteries

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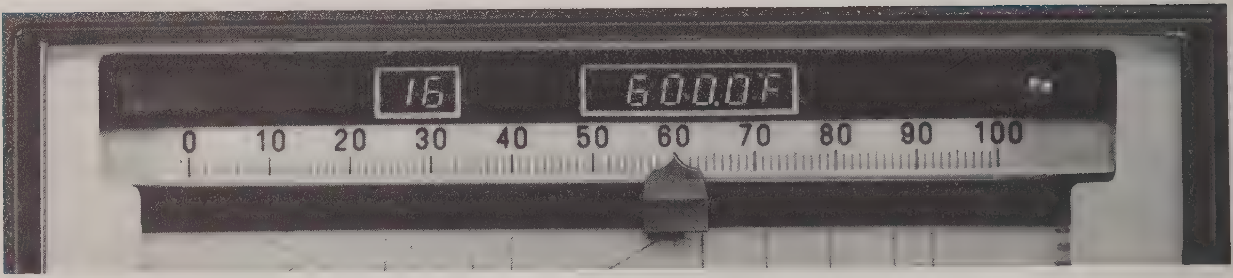
We put you in control.

SPEEDOMAX 1650 & 2500
MULTIPOINT RECORDERS



Bold analog and digital display of measured points — highly visible even in dim light — is provided by printhead pointer against backlighted translucent scale, and large seven-segment LEDs to identify point ("16") and measured value to four significant digits ("600.0°F"). ALARM LED signals alarm status.

The Speedomax 1650 and Speedomax 2500 Multipoint Recorders, incorporating a unique combination of microprocessor-based recording and alarming capabilities, are available for quick delivery, field-programmable to your application requirements.

Both the 1650 and 2500 for thermocouples and emf inputs have basic 15 point recording capability; the 2500 can be extended to 30 points, with a plug-in card. The 2500 (RTD) for RTD inputs (also having thermocouple and emf measuring capability) has basic 10 point recording, expandable to 20 points with a plug-in card. With optional alarming, the 1650 can activate two relays; the 2500, from two to twelve relays.

Except for these differences—and the difference in chart and scale width—the recorders are identical in programming, operation and performance.

RECORDING

The Speedomax 1650/2500 utilizes a proven thermal printhead to produce a bright blue dot, with or without an identifying number ("01" to "15" or "30") on a thermal chart, 30° forward from the top of the drive roll.

At the same time, an integral pointer provides an analog indication along a translucent, backlighted calibrated scale above the chart. An LED display above the scale shows the point number and the value of the measured variable (to four significant figures) plus "F" or "C" for temperature ranges. When time per point is longer than 1 second, measured value, alarm status and digital display are updated every second; printing occurs during the final second.

The recorder will cycle through the measurement of each active point; skipped points are passed with no loss of time.

To facilitate identification of curves with minimum "clutter", vertical spacing between numbers on a trace is selectable (in 0.1″ increments), and is constant regardless of changes in chart speed.

Month/day/hour (or day/month/hour) is printed at the left edge of the chart at noon and midnight, and the appropriate hour ("00" to "23") in between. If input failsafe has been selected, an open-circuit input will print at the right edge of

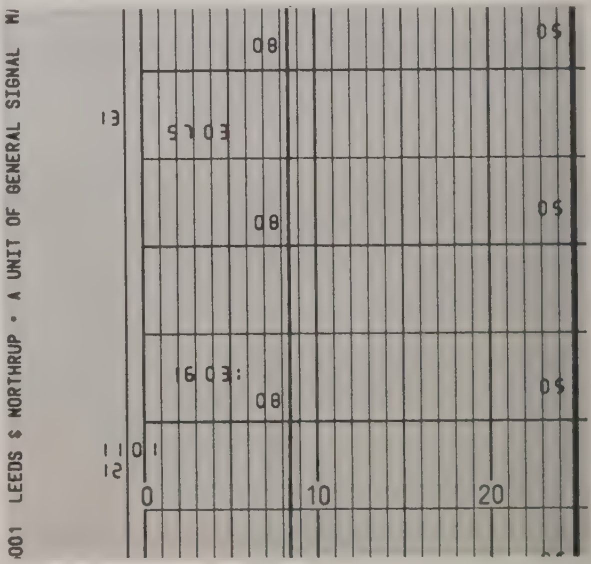
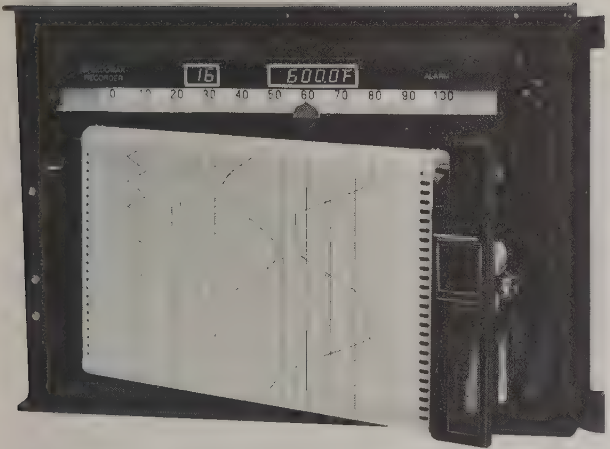


Chart segment (actual size) shows typical record; vertical spacing of point numbers is selectable, to 9.9″. At left, month/day/hour is printed at midnight and noon, with the hour printed in between. Inside the left edge, a minute-and-point record verifies an alarm status (in — "16 03:"; out — "57 03").



Door swings open 180°, providing quick access to pushbuttons at bottom right of recorder chassis. Chart transport swings out to left, permitting easy, rapid chart replacement without interrupting the scanning of measured points.

the chart, and may be configured to activate an alarm; the LED display will read "OPEN".

Scanning time per point is programmable from 1 to 180 seconds, in 1-second increments. The chart stepper-motor is programmable from 1" to 240" per hour, in 1"/hr increments; dual speeds are programmable, with manual or automatic transfer to the second speed. A quickly-accessible "FAST MODE" button can switch the recorder to a 1-second per point printing speed and the second chart speed, for enhanced display in critical situations.

COMMUNICATIONS

An optional RS422/485 serial communications port can be added by installing a Communications Option Kit. This enables the recorder to be interfaced with a host computer for gathering data. The communications system permits up to 30 recorders on a single link in a multi drop type of configuration. Maximum cable length is 1000 feet.

RANGES

The microprocessor-based 1650 or 2500 Recorder can be programmed (for each point, or group of points) for millivolt ranges, from 1-mV to 5000-mV span; voltage ranges (using an optional 20:1 voltage divider), from 5-V to 100-V span; or spans (1 mV, minimum) for Type B, E, J, K, N, R, S or T thermocouples. Linearization for thermocouple inputs is field-selectable; for direct inputs, reference-junction compensation is automatic.

The 2500 (RTD) Recorder can likewise be programmed (for each point or a group of points) for 10 ohm copper, 100 ohm platinum and 1000 ohm platinum RTDs. In addition, temperature ranges for Type E, J, K, S or T thermocouples can be programmed as well as emf ranges. Input relays switch all 3 RTD leads (A, B, C) providing complete isolation between input points, eliminating ground potential problems.

On special order, a PROM containing linearization for a non-standard range, assignable to one or more points, can be provided.

ALARMING

When alarming capability is added, by plugging in the Alarm Program Module, from one to four alarm levels (set points) can be programmed for every point. Each level can initiate one of four alarm actions: high or low alarming, or positive or negative rate-of-change alarming. Alarms can also be grouped in "AND" logic—*all* points in a group must be in alarm to actuate a relay—or "OR" logic—any *one* point in a group will actuate a relay when in alarm.

Whenever a point goes into and out of alarm status (even if it is in an "AND" logic group), the point number will be printed on the chart just inside the left margin, with the time in minutes (each hour is normally printed at the left margin of the chart).

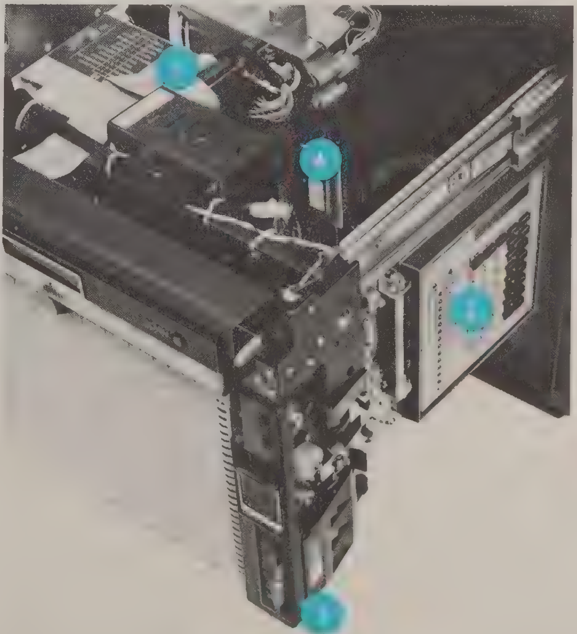
When a point in alarm is being scanned and printed, the bold LED alarm light above the right end of the scale will also light, if an alarm relay is activated.

A DIP switch on the CPU board within the case permits programming the recorder to change automatically to 1-second per point printing speed and the second (fast) chart-drive speed on any alarm.

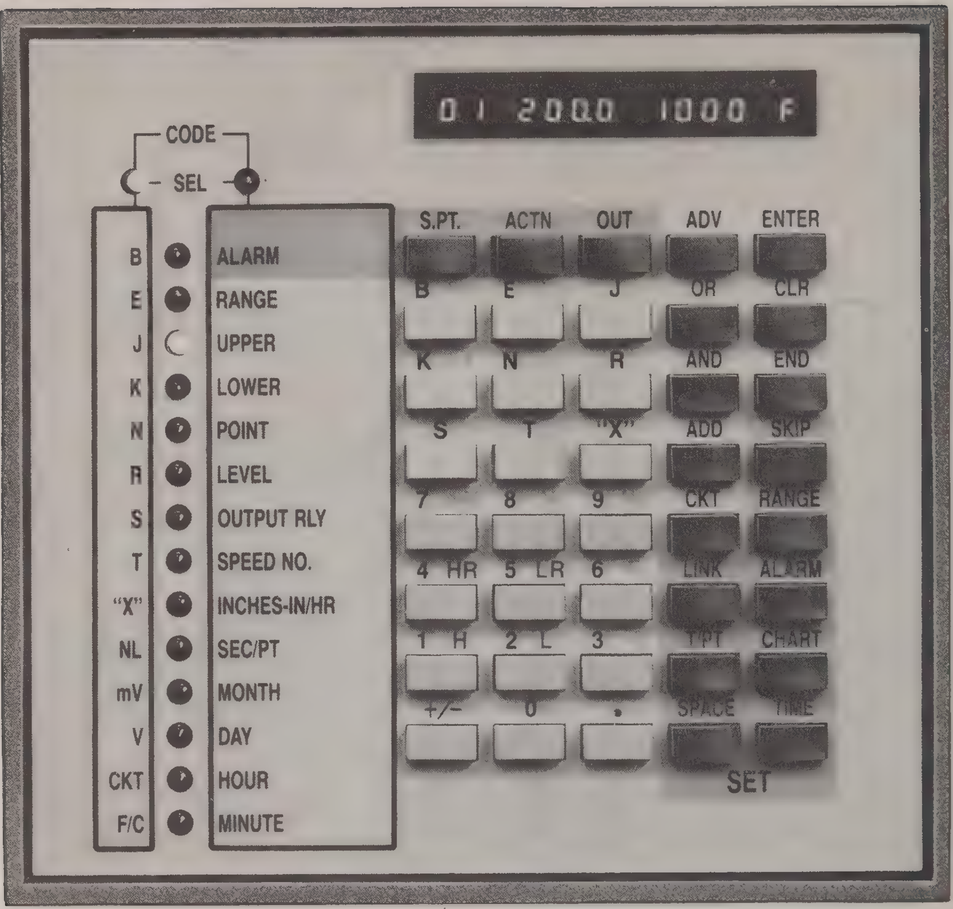
FUNCTION AND PROGRAM SELECTION

Three modules provide switch and pushbutton selection of recorder functions and programming, logically grouped by usage.

1. Six pushbuttons on the front of the recorder chassis (but behind the door) are readily accessible to modify recording action and reset alarm relays. A "POINT HOLD"



Chassis withdrawn to detent position. Printed diagram (1) guides programming of DIP switch on CPU board below; calculator-type keyboard (2) swings out and locks to facilitate programming or review of data; pushbutton array (3) is accessible on front of chassis. Alarm Program Module (4) provides alarm programming.



The calculator-type input keyboard used on the Speedomax 1650/2500 for thermocouple and emf measurements (shown actual size) features 16 discrete LEDs (at the left) to guide the operator through 14 range-related or function-related selections, in conjunction with the labelled, color-coded and logically grouped pushbuttons. The 14-character alphanumeric display (at the top) shows programmed data for review or change (here, Range #1 has a range of 200.0 to 1000°F—for type J thermocouple, as indicated by the LEDs at left). . . can also display self-diagnostic codes to assist in servicing. Programmed data can be reviewed at any time; changing the data requires a four-digit security code for access

button locks to hold the cycle at a selected point. A "POINT ADV" button (non-locking) advances the recorder through the scanning cycle, without printing, until the desired point is reached. "CHART ON-OFF" activates the chart drive. "CHART HI-LO" switches the chart drive from the #1 to the #2 programmed chart speed. "FAST MODE" locks in to provide 1-second-per-point printing and #2 (high) chart speed for enhanced recording display. "ALARM RESET" (non-locking) resets all alarm relays.

2. A calculator-type keyboard, mounted on the right side of the recorder chassis, can swing out to lock in position when the chassis is withdrawn. The keyboard features a 14-character LED display, and 16 discrete LEDs to guide the operator through the programming sequence. Pushbuttons, clearly labelled and in logical groupings, facilitate establishing range spans and alarm actions for each point, chart speeds, time per point, spacing between numbers on the chart, etc. Data is stored in non-volatile memory, assuring retention if power is low (brownout) or off; the real-time clock is backed up by rechargeable batteries, good for 500 hours of operation. All data is accessible for viewing at any time; a security code (four-digit number) must be entered to change any data.

3. A ten-unit DIP switch located on the CPU board, on the recorder chassis, permits selecting basic modes of operation: (a) operation on 50 or 60 Hz line frequency; (b) printing selections: time/date printing, in month/day or day/month format, and input failsafe (upscale) printing; and (c) alarm actions: chart- and print-speed change on alarm, printed record of the time a point goes into and out of alarm, alarm action on input failsafe, automatic reset of alarm relays, and locking or momentary alarm-relay action.

CONSTRUCTION

Among its many features, the recorder servo system employs an enclosed conductive-plastic slidewire, protected from contamination by dust or dirt, or from accidental damage; the servo amplifier has electronic end-stops to eliminate drive-cord wear and the impact damage that often occurs with mechanical end-stops. Digital indication of mea-

sured value (LED display) and alarm detection and action are independent of the servo balance; even if the balancing motor failed, the instrument would continue to scan the measured points for alarms.

Input relays are encapsulated and hermetically sealed for protection against dust, dirt and fumes. A sturdy isothermal terminal block, under cover on the rear of the case, will accept up to 12-gauge wire, secured by strong, easily accessible screws. The carriage for the printhead has an oversize bushing which prevents end-play, so the printhead never wobbles. The die-cast aluminum construction of chassis and case provides the ruggedness required for adverse industrial environments.

SIMPLE MAINTENANCE AND SERVICING

Maintenance or service of the recorder is a quick and simple procedure. The gasketed door, which swings open a full 180°, is easily removable, and the entire internal chassis slides out for ease of servicing. (If necessary, it can be lifted out, for bench servicing.) The paper drive swings out to permit rapid loading of the paper, without interrupting the point-scanning cycle. Over 90% of all parts are common to both the Speedomax 1650 and the Speedomax 2500, assuring minimum parts-storage requirements.

Specifications

Speedomax 1650 and 2500 Multipoint Recorder specifications meet or exceed performance requirements of ANSI C39.4-1966 and safety requirements of ANSI C39.5-1974.

Models Speedomax 1650 Recorder: 15-point capability. Speedomax 2500 Recorder; 15-point capability, expandable to 30-point capability—both for thermocouple and emf measurements. Speedomax 2500 (RTD) 10 points expandable to 20 with RTD and reduced thermocouple/emf capability.

Type Solid-state microprocessor electronics with digitally controlled servo-balance printing.

Measuring Circuit Analog variable-gain preamplifier, with digital control of display and printing.

Ranges Programmable ranges, assignable to one or more points.

D-C Millivolts: Minimum span, 1 mV; maximum span, 5000 mV (5 V). Maximum Suppression Ratio, 5:1.

D-C Volts: Minimum span, 5 V; maximum high-end voltage 100 V. (Utilizes optional plug-in 20:1 voltage divider.)

D-C Milliamperes: High-level inputs (e.g, 4-20 mA) accommodated by separately-ordered current shunts mounted at the rear terminal board.

THERMOCOUPLES

Standard ISA types (B, E, J, K, N, R, S, T). Model 2500 (RTD), types E, J, K, S, T. Reference junction compensation is automatic. RTD: 10 ohm copper, 100 ohm platinum, 1000 ohm platinum.

Custom Linearization: A special PROM containing linearization data for one non-standard range—assignable to one or more points—can be separately ordered and installed by the user.

Indicating Scale Translucent scale, with uniform 0-100 calibration. (Scales with customized calibrations can be separately ordered for field installation.) For Speedomax 1650, scale is 165 mm (6½" nominal) calibrated length; for Speedomax 2500, 250 mm (10" nominal) calibrated length.

Digital Display LED two-digit point identification ("01" to "30"), and a measured-variable display—four digits, with decimal point, minus sign ("−"), and "F" or "C", as required. Alarm indicator LED is to the right.

Fluorescent Light Fluorescent light provides backlighting of the translucent scale and illumination of the chart record.

Chart Printout

(a) Measured Points: Two-digit-plus-dot printing by thermal head, positioned 30° forward of vertical. Recorder balancing motor has electronically controlled end-stops. Spacing between identifying numbers on a trace—adjustable from 0 to 9.9" in 0.1" increments—is independent of chart speed.
(b) Open Inputs: Printed in the right-hand margin; digital display during printing reads "OPEN". (Failsafe operation may be programmed to trigger an alarm.)
(c) Time: Time is printed in the left margin on the hour, with month/day/hour (or day/month/hour) at midnight and noon. Time printing is switch-selectable.
(d) Alarms: Point number will be printed just inside the left margin, with the time in minutes, when a point goes into and out of alarm.

Alarm Capability Programmed by a separately ordered plug-in PROM module.

Programming: Digital alarming can provide 1 to 4 set points for each input, individually programmed (to a maximum of 120, for 30 points). Each set point can initiate 1 of 4 alarm actions: high or low alarming (based on discrete measured-variable values) or positive or negative rate-of-change alarming.

Accuracy: Accuracy of the alarm action is equal to the displayed value ±1/2 digit; of the rate-of-change alarm setting:

$$\frac{\pm[(2\times\frac{\text{samples}}{\text{minute}}\times\text{LED Display Accuracy})\%+0.1\%]\text{display span}}{\text{Rate set point}} =$$

$$\text{Rate Accuracy where } \frac{\text{samples}}{\text{minute}} \leq 4$$

Alarm Light: Red LED above right side of scale lights when any alarm relay is activated.

Recorder Responses: Selectable responses, on alarming, of (a) chart-drive speedup, to a selected faster speed, and/or (b) print-speed increase, to 1 second per point.

Alarm Relays Two alarm relays, mounted in each recorder, are activated by separately ordered Program Module. Contact rating is 5 A on 120 V a-c. (An optional plug-in card, increasing the total to 12 relays, can be separately ordered for the Speedomax 2500 only.) Relay action is normally lock-in; momentary action may be switch-selected (for all).

A given relay may be programmed to indicate an alarm:
(a) on *any one* point-level;
(b) on *any one of several* point-levels, on an "OR" basis;
(c) on *all* point-levels within a group, on an "AND" basis; or
(d) on *any one of a series of groups* of point-levels, where all point-levels within a group must be in alarm for the group to be in alarm—an "AND" basis within a group, an "OR" basis between groups.

Relays may be automatically reset, or the "ALARM RESET" pushbutton on the front of the recorder can provide a common manual reset.

Data Entry Keyboard Calculator-type keyboard, with number keys plus operating and programming buttons, features 14-character LED display and 16 discrete LEDs. Mounted on right side of recorder chassis, keyboard swings out and locks in position for programming or viewing.

Serial Communications: Optional RS422/485 port.

Memory Data All user-entered data and programming are stored in non-volatile memory, assuring full retention of data if power is low or off. The real-time clock is backed up by rechargeable batteries, for continued operation during a power outage up to 500 hours. Self-diagnostic features are included to assist during servicing. A four-digit security code (field-selectable) must be entered at the keyboard to alter any of the programmed data in memory; any stored data may be reviewed without using the code.

Impedance Input, minimum: for thermocouple/emf measurements only: 2700 ohms instantaneous, 5 megohms at 200 msec; 100,000 ohms with optional voltage divider. Source, maximum: 10,000 ohms.

LED Display Accuracy At 25°C. See Note 1.

(a) For mV (1 to 5000) Inputs: ±0.15 (1 + Suppression Ratio) % of span ±3μV ± 1/2 digit.

(b) For Volt Inputs with optional Voltage Divider: Add ±0.5% of span to (a).

(c) For Thermocouple Inputs: Add ±1/2°C to (a).

For temperatures other than 25°C, add ±(0.007% ±0.13 μV)/°C to (a) or (b), or ±(0.007% ±0.1°C)/°C to (c).

For RTD inputs: ±0.15 (1+ .67 suppression ratio) % of span, ±0.003 ohms, ±½°C, ±½ digit.

For temperatures other than 25°C, add ±0.02% of span ±0.00013 ohms/°C deviation from 25°C.

Pointer-Position Accuracy ±0.20% of full-scale span relative to the displayed variable.

Pointer-Position Deadband 0.1% of full-scale span.

Span Step-Response-Time Rating 1 second, nominal.

Note 1. For source resistances (R) above 1,000 ohms add ±[0.05 R(kΩ) ÷ Span (mV)]% of span. For thermocouples and emf only Suppression Ratio. Low end of input divided by input span in V, mV or ohms

Time Per Point Field-selectable from 1 to 180 seconds per point, in 1-second increments. Pointer position and display are updated each second

Chart Speed Field-selectable, from 1 to 240 in./hr, in 1 in./hr increments.

Chart Thermal-sensitive, producing a blue record; calibration and time lines, and calibration data, are printed in red. 0-to-100 uniform chart supplied with each recorder is 36.5 m (40 yd) long.

Temperature Limits For rated operation: 15°C to 40°C (59°F to 104°F). For extreme operation: −9°C to 50°C (16°F to 122°F). For storage: −40°C to 70°C (−40°F to 158°F).

Relative Humidity Limits 10% to 90% R.H., non-condensing.

Common-Mode Rejection At power-line frequency, 80 dB. Voltage limit—100 V dc and peak ac.

Normal Mode (Transverse) Rejection Equal to or greater than 60 dB at power-line frequency and above.

Radio Frequency Interference (RFI) No effect on performance specifications at a distance of 1 m (3.1 ft) from a 5 watt transmitter operating at 27, 150 or 465 MHz.

Power Requirements 120 or 220 V, 50 or 60 Hz, 50 VA. Recorder is supplied for operation on 120 V, 60 Hz; line-voltage rating can be changed with a slide-switch on the rear terminal board, line-frequency rating with an internal DIP switch. Internal on-off power switch and line fuse are standard.

Case Dimensions 1650 Recorder: 13½″ (w) × $12\frac{7}{32}$″ (h) × 14¾″ (d) (343 × 310.4 × 374.7 mm). 2500 Recorder: $16\frac{27}{32}$″ (w) × $12\frac{7}{32}$″ (h) × 14¾″ (d) (427.8 × 310.4 × 374.7 mm).

Weight 1650 Recorder: approximately 48 lb (21.8 kg). 2500 Recorder: approximately 56 lb (25.4 kg).

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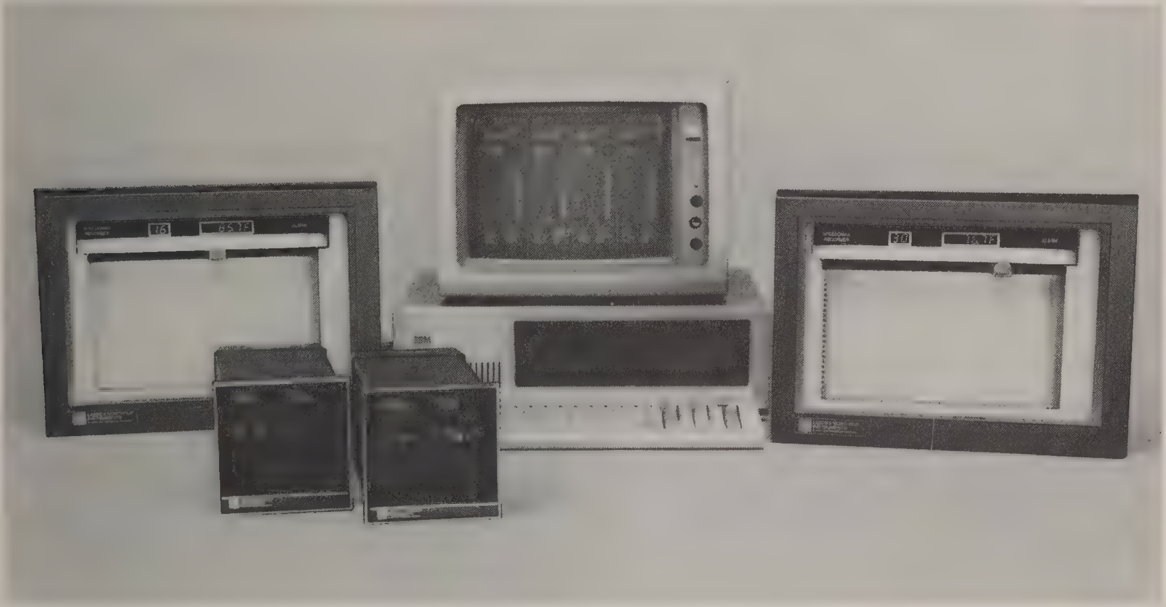
PC-8500 Computer Interface Software for SPEEDOMAX® 1650/2500 Recorders and Electromax® V^PLUS^ Controllers



- Centralized process interface enables remote operation of up to 30 Speedomax 1650/2500 recorders or up to 60 Electromax V^{PLUS} controllers
- Individual recorder point or controller tag names
- Central alarm reporting and printout of process upsets
- Scheduled printout or computer disk storage of process variables and controller setpoints for documenting process performance
- Complete recorder or controller configuration storage and download for rapid controller substitution or process turnaround
- Recipe storage and downloading to controllers using user-defined recipe names assures reproducible program cycles
- Software provides interfaces for both Speedomax 1650/2500 recorders and all Electromax V^{PLUS} controllers (PID, On/Off, Limit)
- Single loop integrity and strip chart records provide maximum process/production security
- Runs on industry standard computers—IBM XT, AT, and 5531
- Customizing service available for items such as custom report formatting, trending, process optimization, security access, custom recipe entry

The Leeds & Northrup Computer Interface Software package takes full advantage of the Speedomax 1650/2500 recorder's and Electromax V^{PLUS} controller's Serial Communications Option and the power of the IBM personal computer. The computer serves as the master or supervisor with each recorder or controller a slave supporting the data acquisition or loop control function independently. Up to two multidrop links can support any combination of recorders and controllers up to a maximum of 30 recorders or 60 controllers (30 per link).

The software Application package provides a practical solution for remotely monitoring, operating, downloading, and recording data from multiple controllers and recorders. Use of the software package can serve as a first or continuing step toward automating plant operations.

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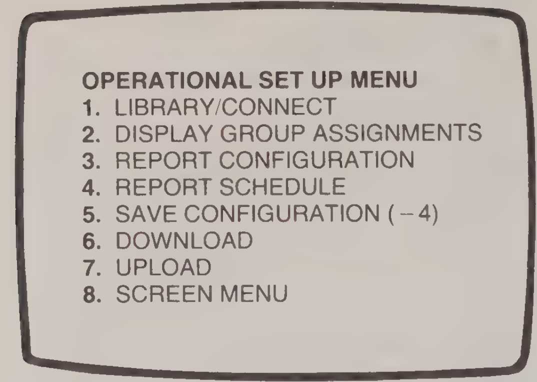
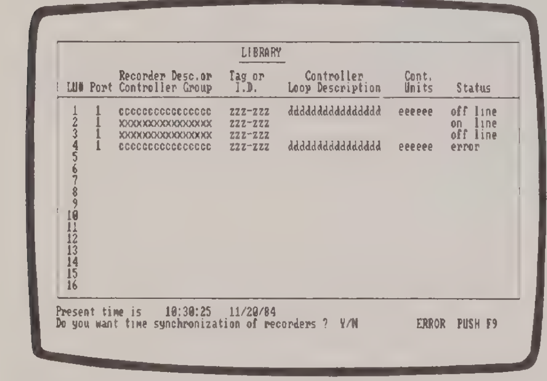
Operating Functions Via Menu Lists



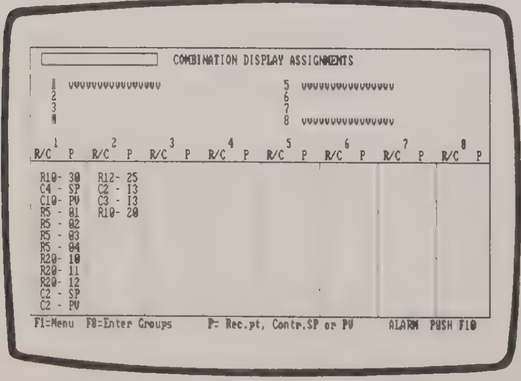
```
OPERATIONAL SET UP MENU
1. LIBRARY/CONNECT
2. DISPLAY GROUP ASSIGNMENTS
3. REPORT CONFIGURATION
4. REPORT SCHEDULE
5. SAVE CONFIGURATION (-4)
6. DOWNLOAD
7. UPLOAD
8. SCREEN MENU
```

Operational Set Up Menu—The recorder and controller On-line and Off-line status, display group assignments, report configurations and report schedule may be stored on computer disk using the Save Configuration selection. These preconfigured selections will then be automatically executed upon process selection when entering the RUN program.



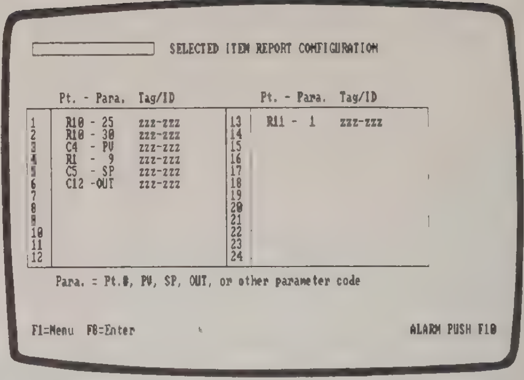
```
                                  LIBRARY

       Recorder Desc.or   Tag or      Controller      Cont.
LU# Port Controller Group  I.D.    Loop Description   Units    Status

 1   1  cccccccccccccccc  zzz-zzz  dddddddddddddddd  eeeeee  off line
 2   1  xxxxxxxxxxxxxxxx  zzz-zzz                            on  line
 3   1  xxxxxxxxxxxxxxxx  zzz-zzz                            off line
 4   1  cccccccccccccccc  zzz-zzz  dddddddddddddddd  eeeeee  error
 5
 6
 7
 8
 9
10
11
12
13
14
15
16
Present time is    10:30:25   11/20/84
Do you want time synchronization of recorders ?  Y/N        ERROR  PUSH F9
```

Library/Connect Screen—Provides a list of all recorders and controllers defined in the Process Definition file, including group identification, tag names, loop descriptions and units of measure. The On-line or Off-line status of each unit may be viewed or altered and time synchronization of all recorder clocks may be performed using simple keyboard entry.



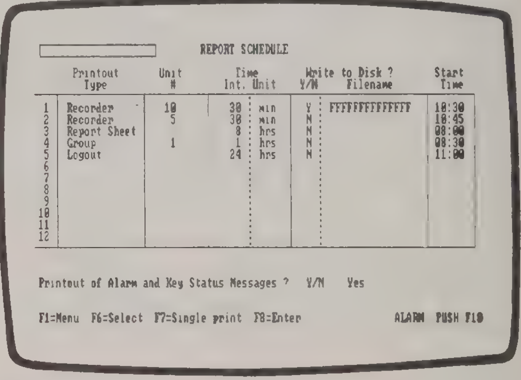
```
               COMBINATION DISPLAY ASSIGNMENTS

  1  vvvvvvvvvvvvvvvv                    5  vvvvvvvvvvvvvvvv
  2                                      6
  3                                      7
  4                                      8  vvvvvvvvvvvvvvvv
    1        2        3        4        5        6        7        8
R/C   P  R/C   P  R/C   P  R/C   P  R/C   P  R/C   P  R/C   P  R/C   P

R10- 30  R12- 25
C4 - SP  C2 - I3
C10- PV  C3 - I3
R5 - 01  R10- 20
R5 - 02
R5 - 03
R5 - 04
R20- 10
R20- 11
R20- 12
C2 - SP
C2 - PV
F1=Menu  F8=Enter Groups     P= Rec.pt, Contr.SP or PV     ALARM  PUSH F10
```

Combination Display Assignment Screen—This data entry screen permits grouping recorder points and controller process variables or setpoints into a common display group. A maximum of 12 parameters may be combined for viewing on the Combination Group and Bar Graph displays, for printing or for storage on computer disk. A maximum of 8 groups may be identified.



```
                 SELECTED ITEM REPORT CONFIGURATION

     Pt. - Para.  Tag/ID                 Pt. - Para.  Tag/ID
 1    R10 - 25    zzz-zzz          13   R11 -  1    zzz-zzz
 2    R10 - 30    zzz-zzz          14
 3    C4  - PV    zzz-zzz          15
 4    R1  -  9    zzz-zzz          16
 5    C5  - SP    zzz-zzz          17
 6    C12 -OUT    zzz-zzz          18
 7                                 19
 8                                 20
 9                                 21
10                                 22
11                                 23
12                                 24
    Para. = Pt.#, PV, SP, OUT, or other parameter code

F1=Menu  F8=Enter                                    ALARM PUSH F10
```

Report Configuration Screen—The Report Configuration entry screen permits assigning up to 24 parameters from any controller, or measured variable from any recorder on either of two links for printing or disk storage. The variables entered in this configuration may be viewed on the Report display in the RUN program. The update rate for this data is selected using the Report Schedule Entry Screen.

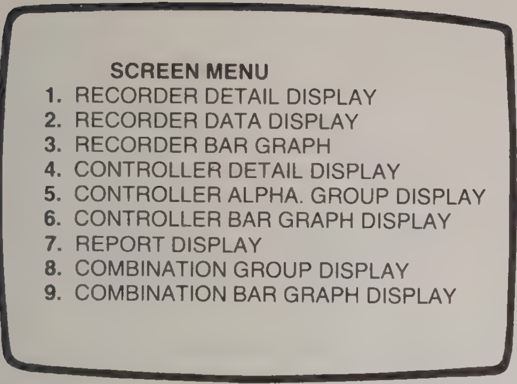


```
                        REPORT SCHEDULE
      Printout       Unit       Time      Write to Disk ?      Start
        Type          #      Int. Unit    Y/N    Filename       Time

 1   Recorder        10        30 : min    Y : FFFFFFFFFFFFFF   10:30
 2   Recorder         5        30 : min    N :                  10:45
 3   Report Sheet               8 : hrs    N :                  08:00
 4   Group            1         1 : hrs    N :                  08:30
 5   Logout                    24 : hrs    N :                  11:00
 6                               :           :
 7                               :           :
 8                               :           :
 9                               :           :
10                               :           :
11                               :           :
12                               :           :

Printout of Alarm and Key Status Messages ?  Y/N    Yes

F1=Menu  F6=Select  F7=Single print  F8=Enter            ALARM  PUSH F10
```

Report Schedule Screen—A data entry screen for scheduling reports going to a printer or storage on computer disk. Files may include Recorder Data screens, Combination Display screens, a Report screen, or a log of all recorder points. If data is stored on disk, user file names identify each file. The update rate and starting time for each file may be independently set in minutes or hours. The printout of alarm messages is determined by a selection on this screen.

Download—Permits user to download either recorder or controller configurations or controller recipes stored on floppy or fixed disk preconfigured for a single controller, controller group, or all controllers.

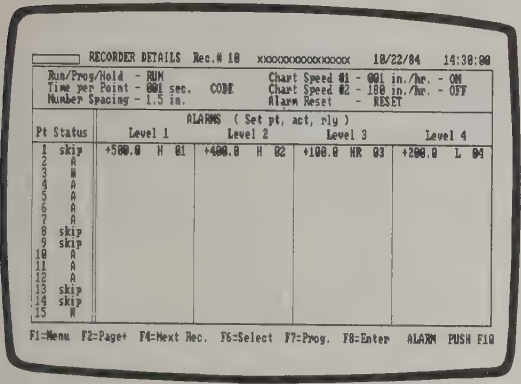
Upload—Permits user to upload a complete recorder or controller configuration or a recipe for a selected controller, controller group, or all controllers to a designated file. Uploaded recorder configuration files may not be altered.



```
SCREEN MENU
1. RECORDER DETAIL DISPLAY
2. RECORDER DATA DISPLAY
3. RECORDER BAR GRAPH
4. CONTROLLER DETAIL DISPLAY
5. CONTROLLER ALPHA. GROUP DISPLAY
6. CONTROLLER BAR GRAPH DISPLAY
7. REPORT DISPLAY
8. COMBINATION GROUP DISPLAY
9. COMBINATION BAR GRAPH DISPLAY
```

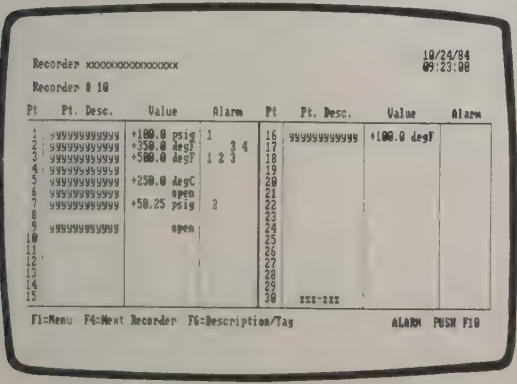
Screen Menu—Selects screen menu list.

Screen Menu (On-Line Displays)



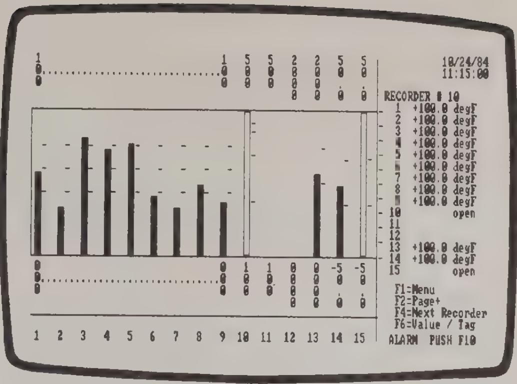
```
      RECORDER DETAILS  Rec.# 10   xxxxxxxxxxxxxxxx    10/22/84    14:30:00
  Run/Prog/Hold  - RUN                  Chart Speed #1 - 001 in./hr. - ON
  Time per Point - 001 sec.   CODE      Chart Speed #2 - 100 in./hr. - OFF
  Number Spacing - 1.5 in.              Alarm Reset    -  RESET
                        ALARMS  ( Set pt, act, rly )
Pt Status       Level 1         Level 2          Level 3          Level 4
 1   skip   +500.0   H  01  +400.0   H  02  +100.0  HR  03  +200.0   L  04
 2    A
 3    █
 4    A
 5    A
 6    A
 7    A
 8   skip
 9   skip
10    A
11    A
12    A
13   skip
14   skip
15    █
F1=Menu  F2=Page+  F4=Next Rec.  F6=Select  F7=Prog.  F8=Enter   ALARM  PUSH F10
```

Recorder Detail Display—Provided for each recorder and accessed by recorder number, this screen permits the user to alter recorder parameters from the keyboard. The user may change asterisked (*) parameters including recorder run/program/hold status, point skip status, alarm set points, chart speeds etc. A code number is available for security on recorder data.



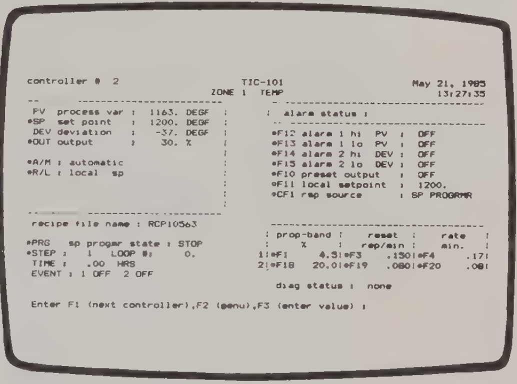
```
Recorder xxxxxxxxxxxxxxxx                                            10/24/84
                                                                     09:23:00
Recorder # 10

Pt   Pt. Desc.       Value      Alarm   Pt   Pt. Desc.      Value      Alarm
 1  yyyyyyyyyyyy  +100.0 psig  1        16  yyyyyyyyyyyy  +100.0 degF
 2  yyyyyyyyyyyy  +350.0 degF      3 4  17
 3  yyyyyyyyyyyy  +500.0 degF  1 2 3    18
 4  yyyyyyyyyyyy                        19
 5  yyyyyyyyyyyy  +250.0 degC           20
 6  yyyyyyyyyyyy         open           21
 7  yyyyyyyyyyyy  +50.25 psig   2       22
 8                                      23
 9  yyyyyyyyyyyy         open           24
10                                      25
11                                      26
12                                      27
13                                      28
14                                      29
15                                      30    zzz-zzz
F1=Menu  F4=Next Recorder  F6=Description/Tag                    ALARM  PUSH F10
```

Recorder Data Display—Provides current variable information and alarm status for all points on a single recorder. Active alarm levels are indicated with a red level number. Point description and point tag names share a common display area and alternate by depressing a dedicated key.



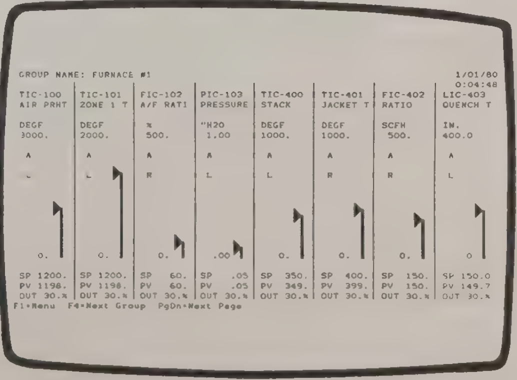
```
                                                       10/24/84
                                                       11:15:00
                                                  RECORDER # 10
                                                    1  +100.0 degF
                                                    2  +100.0 degF
                                                    3  +100.0 degF
                                                    4  +100.0 degF
                                                    5  +100.0 degF
                                                    6  +100.0 degF
                                                    7  +100.0 degF
                                                    8  +100.0 degF
                                                    9  +100.0 degF
                                                   10         open
                                                   11
                                                   12
                                                   13  +100.0 degF
                                                   14  +100.0 degF
                                                   15         open

                                                    F1=Menu
                                                    F2=Page+
                                                    F4=Next Recorder
                                                    F6=Value / Tag
1  2  3  4  5  6  7  8  9  10  11  12  13  14  15  ALARM  PUSH F10
```

Recorder Bar Graph Display—Bar graph indication for 15 points from a single recorder is provided. A second screen, selectable by single key, is available for recorders with more than 15 points.



```
controller #  2                      TIC-101                       May 21, 1985
                                  ZONE 1  TEMP                         13:27:35
--      -------------------------             -----------------------------------
 PV  process var  :  1163. DEGF  :            :  alarm status :
*SP  set point    :  1200. DEGF  :             -- --------------------------------
 DEV deviation    :   -37. DEGF  :             *F12 alarm 1 hi  PV  :  OFF
*OUT output       :    30. %     :             *F13 alarm 1 lo  PV  :  OFF
                                 :             *F14 alarm 2 hi  DEV :  OFF
*A/M : automatic                 :             *F15 alarm 2 lo  DEV :  OFF
*R/L : local  sp                 :             *F10 preset output   :  OFF
                                 :             *F11 local setpoint  :  1200.
                                 :             *CF1 rsp source      : SP PROGRMR
                                 :
-- ----  -------------------------
 recipe file name : RCP10563
                                              ----------------------------------
                                              : prop-band :   reset   :   rate  :
*PRG   sp progmr state : STOP                 :     %     :  rep/min  :   min.  :
*STEP :   1   LOOP #:     0.                 1:*F1    4.5:*F3    .150:*F4    .17:
 TIME :   .00  HRS                           2:*F18  20.0:*F19   .080:*F20   .08:
 EVENT : 1 OFF  2 OFF
                                                diag status :  none

 Enter F1 (next controller),F2 (menu),F3 (enter value) :
```

Controller Detail Display—Provided for each controller and accessed by controller number. This screen permits the user to alter controller parameters from the keyboard; user may change asterisked (*) parameters including setpoint, alarm values, tuning constants, etc. plus setpoint programmer start/stop, reset, step selection and self-tune hold-off/on. Ratio and bias are also alterable for ratio control. Parameters for options not in a controller are not displayed.

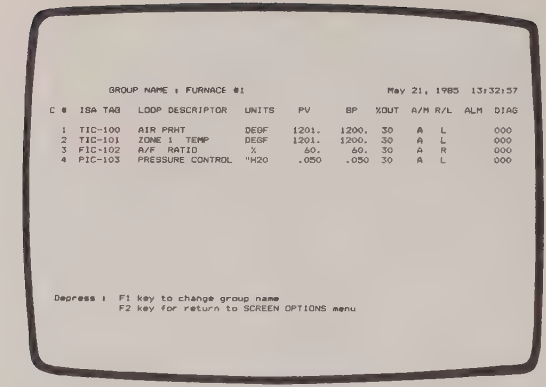


```
GROUP NAME: FURNACE #1                                                          1/01/80
                                                                                0:04:48
TIC-100  | TIC-101  | FIC-102  | PIC-103  | TIC-400  | TIC-401  | FIC-402  | LIC-403
AIR PRHT | ZONE 1 T | A/F RATI | PRESSURE | STACK    | JACKET T | RATIO    | QUENCH T

DEGF     | DEGF     |  %       | "H20     | DEGF     | DEGF     | SCFH     | IN.
3000.    | 2000.    |  500.    |  1.00    | 1000.    | 1000.    |  500.    | 400.0

 A       |  A       |  A       |  A       |  A       |  A       |  A       |  A

 L       |  L       |  R       |  L       |  L       |  R       |  R       |  L




    0.   |    0.    |    0.    |   .00    |    0.    |    0.    |    0.    |    0
SP 1200. | SP 1200. | SP   60. | SP   .05 | SP  350. | SP  400. | SP  150. | SP 150.0
PV 1198. | PV 1198. | PV   60. | PV   .05 | PV  349. | PV  399. | PV  150. | PV 149.7
OUT 30.% | OUT 30.% | OUT 30.% | OUT 30.% | OUT 30.% | OUT 30.% | OUT 30.% | OUT 30.%
F1=Menu  F4=Next Group  PgDn=Next Page
```

Controller Bar Graph Display—Provides a bar representation of a controller group for monitoring, displayed in groups of eight on each screen.

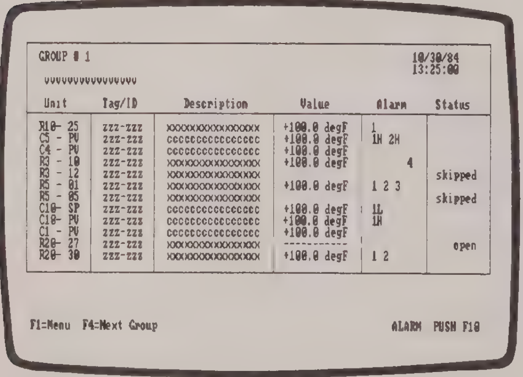
Max. No. of controllers in a group—16

Max. No. of screen pages per group—2



```
GROUP NAME : FURNACE #1                           May 21, 1985  13:32:57

C #  ISA TAG   LOOP DESCRIPTOR    UNITS    PV      SP    %OUT  A/M R/L  ALM   DIAG

 1   TIC-100   AIR PRHT           DEGF    1201.   1200.   30    A   L         000
 2   TIC-101   ZONE 1  TEMP       DEGF    1201.   1200.   30    A   L         000
 3   FIC-102   A/F  RATIO          %        60.     60.   30    A   R         000
 4   PIC-103   PRESSURE CONTROL   "H20     .050    .050   30    A   L         000




Depress :  F1 key to change group name
           F2 key for return to SCREEN OPTIONS menu
```

Controller Alpha. Group Display—Provides same information as controller bar graph display but in alphanumeric format. Displays all controllers in a group (up to 16); monitor only.

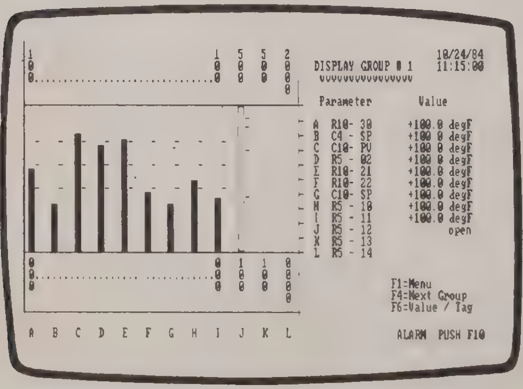


```
GROUP # 1                                                    10/30/84
                                                             13:25:00
 vvvvvvvvvvvvvvvv

 Unit      Tag/ID       Description          Value        Alarm    Status

R10- 25   zzz-zzz   xxxxxxxxxxxxxxxx   +100.0 degF    1
C5 - PV   zzz-zzz   cccccccccccccccc   +100.0 degF    1H 2H
C4 - PV   zzz-zzz   cccccccccccccccc   +100.0 degF
R3 - 10   zzz-zzz   xxxxxxxxxxxxxxxx   +100.0 degF          4
R3 - 12   zzz-zzz   xxxxxxxxxxxxxxxx                              skipped
R5 - 01   zzz-zzz   xxxxxxxxxxxxxxxx   +100.0 degF    1 2 3
R5 - 05   zzz-zzz   xxxxxxxxxxxxxxxx                              skipped
C10- SP   zzz-zzz   cccccccccccccccc   +100.0 degF    1L
C10- PV   zzz-zzz   cccccccccccccccc   +100.0 degF    1H
C1 - PV   zzz-zzz   cccccccccccccccc   +100.0 degF
R20- 27   zzz-zzz   xxxxxxxxxxxxxxxx   -----------                   open
R20- 30   zzz-zzz   xxxxxxxxxxxxxxxx   +100.0 degF    1 2


F1=Menu  F4=Next Group                                    ALARM  PUSH F10
```

Combination Group Display—Provides current process variable and alarm indication for selected recorder points and controllers on the link.

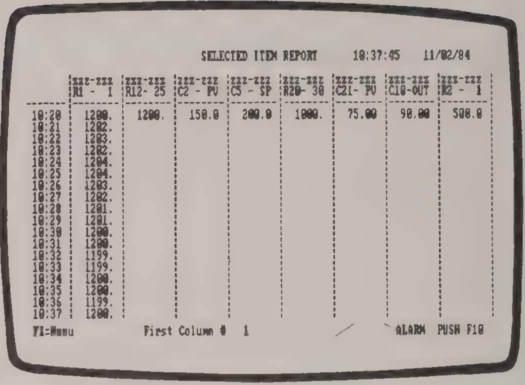
Max. No. of Parameters—12

Max. No. of Groups—8



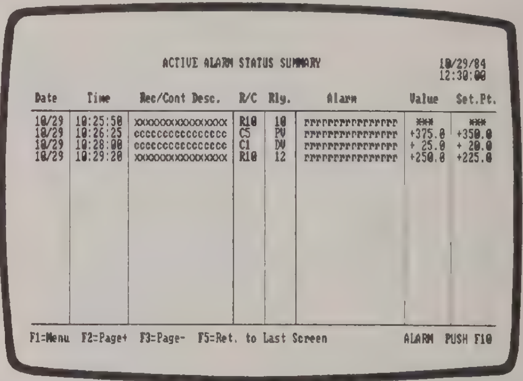
```
DISPLAY GROUP # 1         10/24/84
 vvvvvvvvvvvvvvvv         11:15:00

 Parameter           Value

A  R10- 30        +100.0 degF
B  C4 - SP        +100 0 degF
C  C10- PV        +100 0 degF
D  R5 - 02        +100 0 degF
E  R10- 21        +100.0 degF
F  R10- 22        +100.0 degF
G  C10- SP        +100.0 degF
H  R5 - 10        +100.0 degF
I  R5 - 11        +100.0 degF
J  R5 - 12               open
K  R5 - 13
L  R5 - 14

                 F1=Menu
                 F4=Next Group
                 F6=Value / Tag

                  ALARM  PUSH F10
```

Combination Bar Graph Display—Provides the same information as the Combination Group Display but in bar graph format.



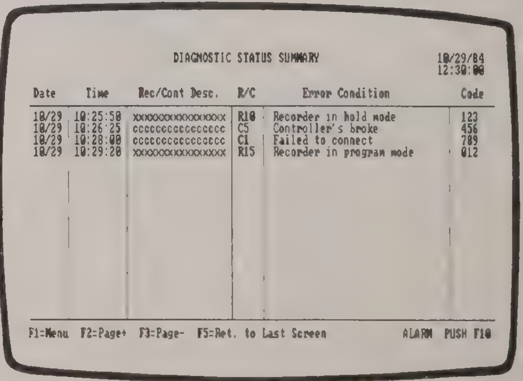
```
                        SELECTED ITEM REPORT     10:37:45    11/02/84

       |zzz-zzz |zzz-zzz |zzz-zzz |zzz-zzz |zzz-zzz |zzz-zzz |zzz-zzz |zzz-zzz |
       |R1  -  1|R12- 25 |C2 - PV |C5 - SP |R20- 30 |C21- PV |C10-OUT |R2  -  1|
-------|--------|--------|--------|--------|--------|--------|--------|--------|
 10:20 |  1200. |  1200. |  150.0 |  200.0 |  1000. |  75.00 |  90.00 |  500.0 |
 10:21 |  1202. |        |        |        |        |        |        |        |
 10:22 |  1203. |        |        |        |        |        |        |        |
 10:23 |  1202. |        |        |        |        |        |        |        |
 10:24 |  1204. |        |        |        |        |        |        |        |
 10:25 |  1204. |        |        |        |        |        |        |        |
 10:26 |  1203. |        |        |        |        |        |        |        |
 10:27 |  1202. |        |        |        |        |        |        |        |
 10:28 |  1201. |        |        |        |        |        |        |        |
 10:29 |  1201. |        |        |        |        |        |        |        |
 10:30 |  1200. |        |        |        |        |        |        |        |
 10:31 |  1200. |        |        |        |        |        |        |        |
 10:32 |  1199. |        |        |        |        |        |        |        |
 10:33 |  1199. |        |        |        |        |        |        |        |
 10:34 |  1200. |        |        |        |        |        |        |        |
 10:35 |  1200. |        |        |        |        |        |        |        |
 10:36 |  1199. |        |        |        |        |        |        |        |
 10:37 |  1200. |        |        |        |        |        |        |        |
F1=Menu          First Column #   1                       ALARM  PUSH F10
```

Report Display—Displays a periodic log of parameters from selected controllers or recorder points per the Report Configuration entry. Maximum of 17 readings displayed. The same information can be routed to a printer or computer disk for each new update. While only 6 columns are displayed, user may tab across screen to view any 6 consecutive columns within a range of 24.



```
                  ACTIVE ALARM STATUS SUMMARY                        10/29/84
                                                                     12:30:00
Date    Time     Rec/Cont Desc.     R/C  Rly.      Alarm          Value   Set.Pt.

10/29  10:25:50  xxxxxxxxxxxxxxxx   R10   10   rrrrrrrrrrrrrrrr     ***      ***
10/29  10:26:25  cccccccccccccccc   C5    PV   rrrrrrrrrrrrrrrr   +375.0  +350.0
10/29  10:28:00  cccccccccccccccc   C1    DV   rrrrrrrrrrrrrrrr   + 25.0  + 20.0
10/29  10:29:20  xxxxxxxxxxxxxxxx   R10   12   rrrrrrrrrrrrrrrr   +250.0  +225.0

F1=Menu  F2=Page+  F3=Page-  F5=Ret. to Last Screen               ALARM  PUSH F10
```

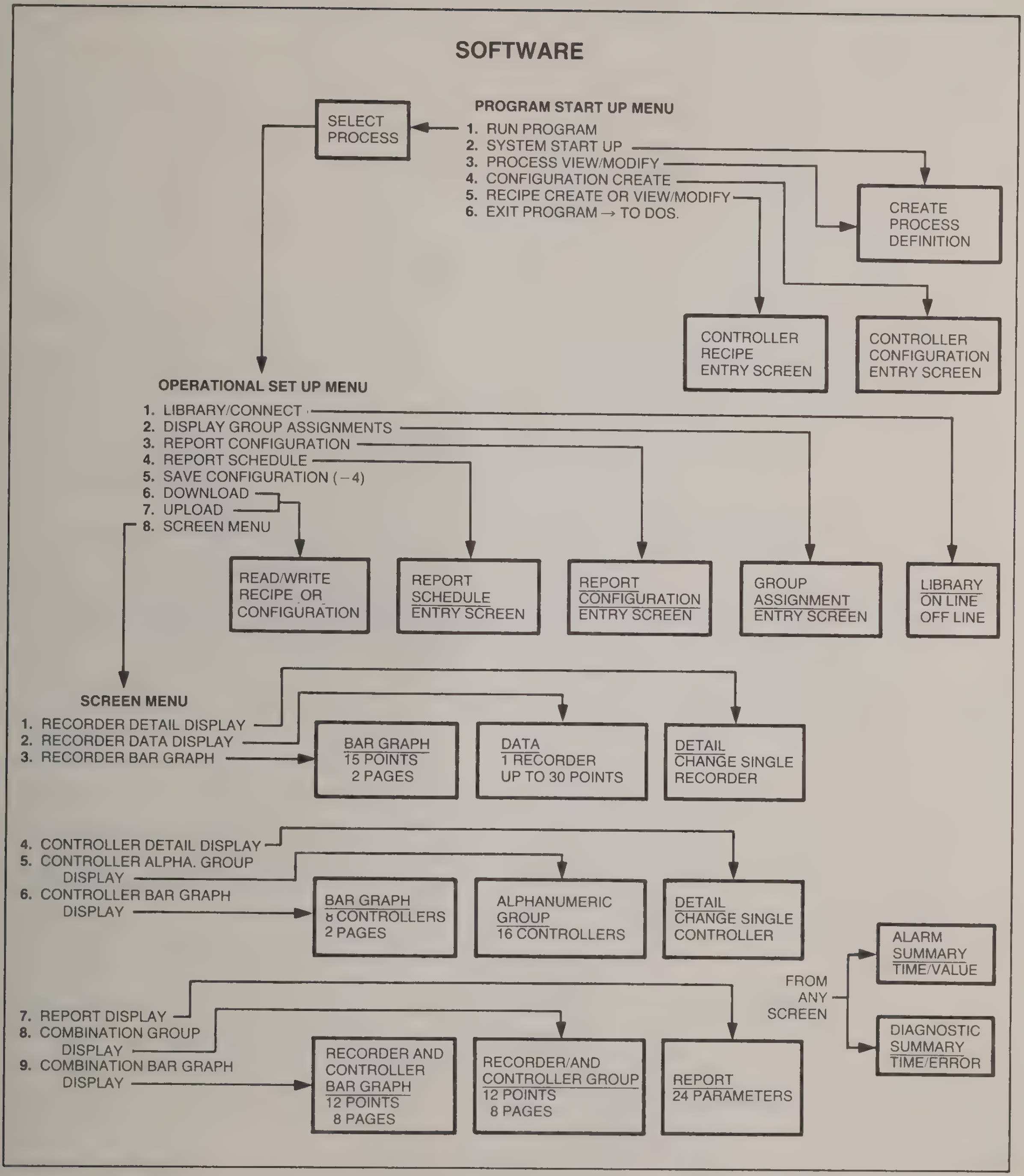
Active Alarm Summary—Displays all active recorder or controller alarms including time of occurrence (to nearest 30 seconds).



```
                  DIAGNOSTIC STATUS SUMMARY                      10/29/84
                                                                 12:30:00
Date    Time     Rec/Cont Desc.    R/C       Error Condition          Code

10/29  10:25:50  xxxxxxxxxxxxxxxx  R10   Recorder in hold mode         123
10/29  10:26:25  cccccccccccccccc  C5    Controller's broke            456
10/29  10:28:00  cccccccccccccccc  C1    Failed to connect             789
10/29  10:29:20  xxxxxxxxxxxxxxxx  R15   Recorder in program mode      012

F1=Menu  F2=Page+  F3=Page-  F5=Ret. to Last Screen          ALARM  PUSH F10
```

Active Diagnostic Summary—Displays all recorder, controller or communication diagnostic errors including time of occurrence, unit identification and error type.

Alarm Scan—All recorders and controllers are scanned for alarms every 30 seconds as a scheduled priority task. A flashing "ALARM PUSH F10" message on any active


SOFTWARE
SELECT PROCESS
PROGRAM START UP MENU
1. RUN PROGRAM
2. SYSTEM START UP
3. PROCESS VIEW/MODIFY
4. CONFIGURATION CREATE
5. RECIPE CREATE OR VIEW/MODIFY
6. EXIT PROGRAM → TO DOS.
CREATE PROCESS DEFINITION
CONTROLLER RECIPE ENTRY SCREEN
CONTROLLER CONFIGURATION ENTRY SCREEN
OPERATIONAL SET UP MENU
1. LIBRARY/CONNECT
2. DISPLAY GROUP ASSIGNMENTS
3. REPORT CONFIGURATION
4. REPORT SCHEDULE
5. SAVE CONFIGURATION (−4)
6. DOWNLOAD
7. UPLOAD
8. SCREEN MENU
READ/WRITE RECIPE OR CONFIGURATION
REPORT SCHEDULE ENTRY SCREEN
REPORT CONFIGURATION ENTRY SCREEN
GROUP ASSIGNMENT ENTRY SCREEN
LIBRARY ON LINE OFF LINE
SCREEN MENU
1. RECORDER DETAIL DISPLAY
2. RECORDER DATA DISPLAY
3. RECORDER BAR GRAPH
BAR GRAPH 15 POINTS 2 PAGES
DATA 1 RECORDER UP TO 30 POINTS
DETAIL CHANGE SINGLE RECORDER
4. CONTROLLER DETAIL DISPLAY
5. CONTROLLER ALPHA. GROUP DISPLAY
6. CONTROLLER BAR GRAPH DISPLAY
BAR GRAPH 8 CONTROLLERS 2 PAGES
ALPHANUMERIC GROUP 16 CONTROLLERS
DETAIL CHANGE SINGLE CONTROLLER
ALARM SUMMARY TIME/VALUE
FROM ANY SCREEN
DIAGNOSTIC SUMMARY TIME/ERROR
7. REPORT DISPLAY
8. COMBINATION GROUP DISPLAY
9. COMBINATION BAR GRAPH DISPLAY
RECORDER AND CONTROLLER BAR GRAPH 12 POINTS 8 PAGES
RECORDER/AND CONTROLLER GROUP 12 POINTS 8 PAGES
REPORT 24 PARAMETERS

APPLICATION SOFTWARE PACKAGE DESCRIPTION

This easy to use program makes available both operating and utility program functions. Utility programs are used to create or modify recipes and configurations and to describe the recorders and controllers with labels used by the operating application program. The operating program provides the operator color video screens and maintains continuous interactive communication between the host computer and all Speedomax 1650/2500 recorders and Electromax V^{PLUS} controllers connected on the link.

After definition files are created using the utility entry screens, operation begins when process definition is selected and the computer is "connected" (via software) to each recorder and controller. The user may then select operations from the Operational Set Up Menu or screen displays from the Screen Menu for recorder or controller supervision.

display indicates presence of a new alarm. Acknowledgement is by accessing the Active Alarm Summary by depressing special function key F10, which causes the alarm message to stop flashing. Only recorder alarms which cause relay action appear on the Active Alarm Summary; alarm levels are not logged.

Alarm Printout—Alarms are printed when first detected and on alarm clear. Only recorder alarms causing relay action are printed; alarm levels are not printed.

Utility Programs

Utility programs are used to create process definition files for recorders and controllers, define controller configuration parameters, and create and assign recipe data files. Entry employs a cursor controlled entry screen for each file. The files created by these utilities are described as follows. Only the Process Definition file is essential for the operating program.

Process Definition File

Created for each recorder or controller, these files provide the unit definitions. Entries include:

a. Recorder or controller unit number, port number, type, physical address.
b. Recorder alarms or controller options present.
c. Tag number (ISA tag).
d. Recorder or loop descriptor—16 characters.
e. Units of measure (per point on recorders).
f. Group name (controllers only).
g. Point description and tag name (recorders only).
h. Alarm descriptors
i. Bar graph scaling—engineering unit scaling of bar graph display limits (controllers only).

Controller Configuration File

Allows the user to define complete controller configurations (F,C,CF functions) which may include range, tuning, scaling, remote setpoint source, control action options, bias arrangements, etc. for Download. Configuration definition files may be created for a single controller, a group of controllers or all controllers. Recorder configuration files may only be created from upload.

Recipe Definition Files (Controllers Only)

Allows the user to create and store recipes identified by unique product names for download. Recipe files include local setpoint, computer setpoint, alarm values and primary tuning parameters. If optional setpoint programming is present in the Electromax V^{PLUS}, the 10 segment program with setpoint guarantees and events is also included. Recipe definition files can be created and downloaded to a single controller, a group of controllers or all controllers. A single recipe may also be downloaded to multiple controllers or controller groups.

Driver Software

The communications driver software consists of a library of subroutines or tasks to enable the programmer to write a specific application program in FORTRAN. All communications and protocol handling is transparent to the user when using the driver "call" statements. Driver software is provided for IBM personal computer hardware. All front panel display and user-programmed parameters (F, CF, C) are accessible enabling full control over multiple Electromax V^{PLUS} controllers or Speedomax recorders.

IBM Package includes:

a) Driver software—module library
b) Application software program and support programs
c) Training software program
d) Documentation for driver and application program software
e) License for one computer.

Compatible Computers

- IBM XT, 5531 or AT
- Operating System—DOS 2.0, 2.1, 3.0
- Number of Async ports supported—2 (COM1 and COM2)
- Number of controllers supported—30 per port (60 max). Number of recorders supported—30 max.
- Required hardware:
  System unit with 640K memory
  IBM Enhanced/Graphics Adapter Board
  IBM Asynchronous Adapter (per port), Serial/Parallel Adapter (AT)
  IBM Color Monitor—medium resolution
  Printer Adapter board plus EPSON-compatible printer
  RS-232-C to RS-422 Interface Adapter (L&N Part No. 063979)

Link Specifications:

Type of network supported: Multidrop, master/slave, RS-422/485 (requires RS-232-C to RS-422 converter for computer RS-232 port).

Baud rates: 300, 1200, 9600

Maximum distance per link: 1000 ft.

Cable: Two twisted shielded pairs, Belden 8723 or 8728 recommended.

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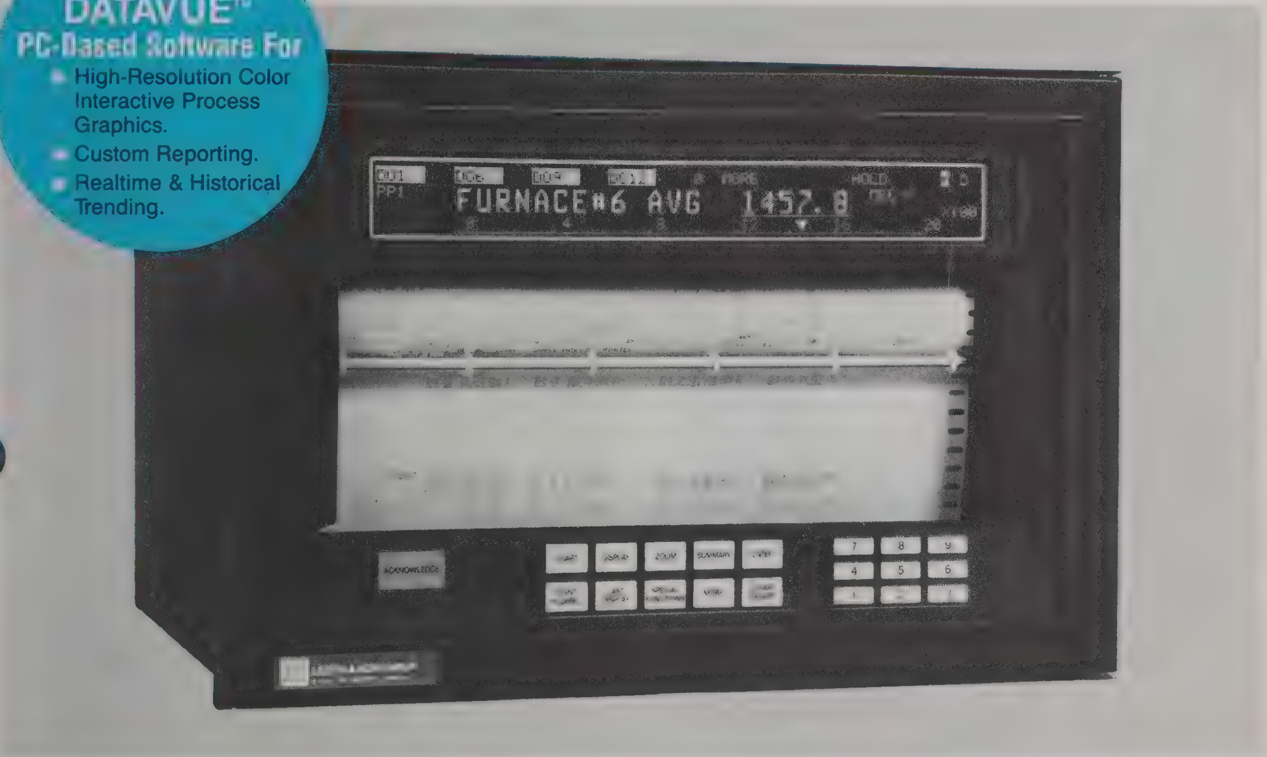
SPEEDOMAX® 25000 SERIES
Hybrid Multipoint Recorders
for Simultaneous Data Logging, Alarm Monitoring & Display

Now Available
DATAVUE™
PC-Based Software For
- High-Resolution Color Interactive Process Graphics.
- Custom Reporting.
- Realtime & Historical Trending.



Major Features

- Outstanding display flexibility
  - Simple keystroke selection for a variety of data display formats.
  - Displays analog scale with large selectable pointer or bar graph.
  - Displays rate-and direction-of process change.
  - Simultaneously displays up to 15 selectable points.
  - Displays point- or tag-ID, 14-character descriptor, measured value, engineering unit, active alarms, diagnostics, and more.
  - Large, clear, alpha-numeric characters.
  - Display is independent of recording and alarm scanning.
- Unequalled recording & data-logging capability
  - "Programmable" analog trend and/or log modes and summary reports.
  - TRENDVUE™ printing gives unobstructed view of latest recorded data.
  - Multi-color continuous lines (dot-filling) even at 200cm/hr.
  - "Zoom" feature instantly expands scale for clearer visibility of trend lines.
  - Scales printed at selected spacings.
  - Up to 3 user-selectable split-chart zones available.
  - Alarms and events printed in right-hand margin.
  - Continuously scans all points for alarms in one second; prints up to 30 points in 5 seconds.
  - Point-Hold allows continuous observation of any single point.
  - Selectable alarm-summary printout.
  - Prints comprehensive data in log mode.

(continued)

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SPEEDOMAX 25000
Hybrid Multipoint Recorder

Major Features (continued)

- **Digital communications to host computer.**
- **Programmable selection of up to 135 scales for display and/or printout.**
- **Powerful capability to compute, print and display "pseudo point" math calculations.**
- **High-speed scanning of up to 120 alarm levels.**
- **Large point capacity, 135 Inputs/Outputs, 240 Inputs/Outputs using digital communications, 60 pseudo points and 50 constants.**
- **Extra long fanfold chart reduces replacements, saves time.**
- **Two keyboards supplied: user-friendly, uncluttered *Operator's Keyboard* on front of instrument; removable, hand-held *Configuring Keyboard*, stored inside or elsewhere. Also accepts any IBM AT-format keyboard.**
- **Input/output cards interchangeable with MICROMAX® Data Management System (AI, AO, DI, DO, Pulse); reduces inventory requirements.**
- **All positioning by digitally controlled precision stepper motors; NO slidewires or servos.**
- **Easy to configure, operate and maintain via prompt-type menu displays, powerful diagnostics.**
- **Optional multi-language operation (English – French – Spanish).**

CPU board contains dependable, time-proven componets.

Swing-out chassis provides easy access to all internal parts for routine maintenance and factory service.

Battery backup protects memory containing configuration data and latest measurements in case of power loss.

INTRODUCTION

The SPEEDOMAX 25000 Hybrid Multipoint Strip-Chart Recorder represents a quantum-step advancement in multipoint recording. Built into this single compact instrument is an impressive *combination* of the most customer-requested features of any recorder in its class. Described in this publication, the unique SPEEDOMAX 25000 Recorder combines the best features of high-quality analog strip-chart recorders with programmable digital data loggers. In addition, it provides high-speed scanning, highly visible display, reporting flexibility, and powerful computation capability.

The SPEEDOMAX 25000 is also highly accurate and dependable. Its engineering, design and construction are based on Leeds & Northrup's long experience with both potentiometric recording and microprocessor-based data acquisition and control.

As a result of its many innovations and combination of features, the SPEEDOMAX 25000 is both easy and economical to install, configure, operate and maintain. You will find it ideal for performing all of the following functions *concurrently*: trend recording, data logging, math calculating, alarming, digital I/O, and analog output.

GENERAL DESCRIPTION

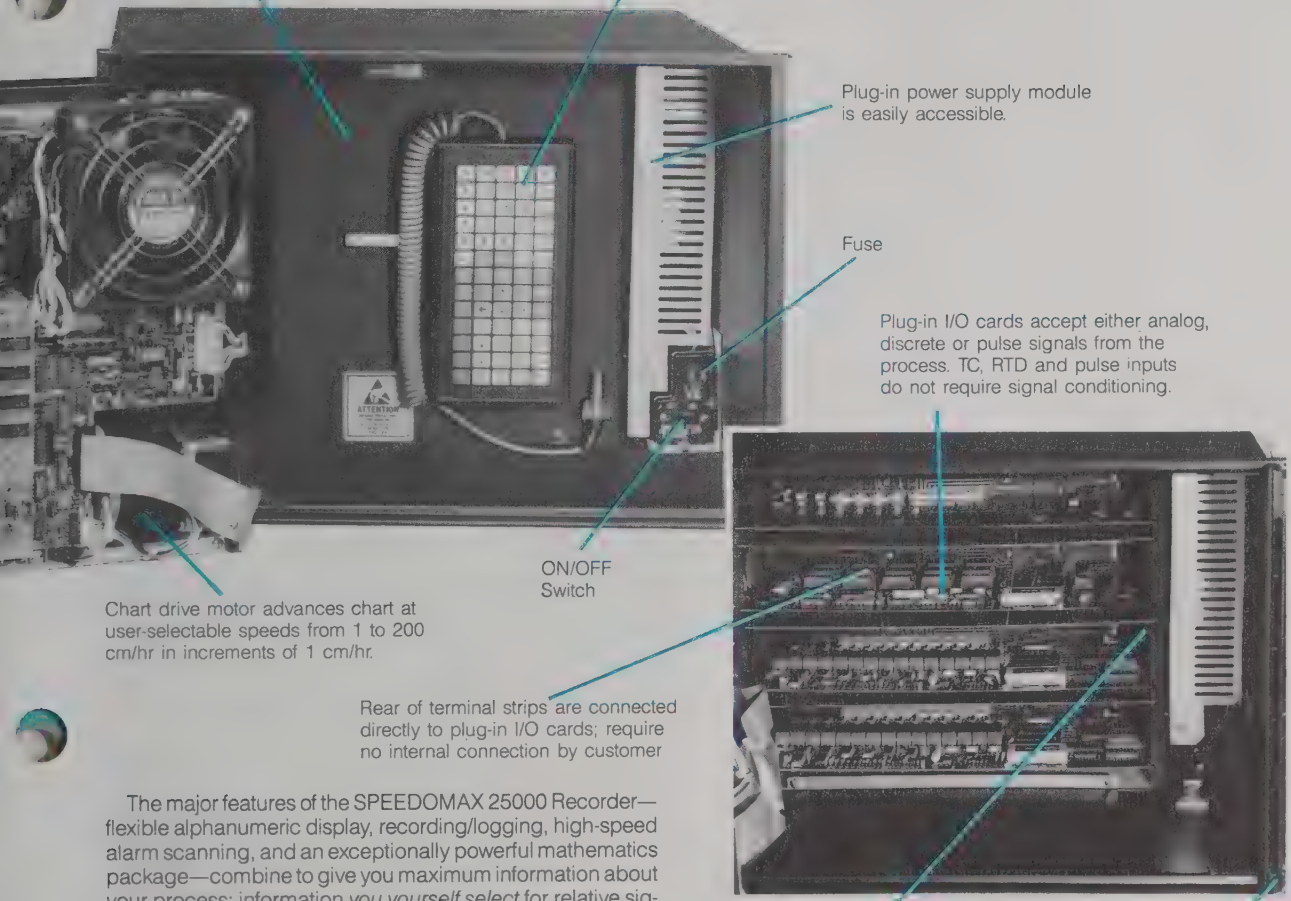
The SPEEDOMAX 25000 is a multipoint, multiple function recorder which can record, display/log and process up to 135 input/output data points either analog or discrete, in various combinations. The basic recorder has a capacity of 60 analog input points in 4 card slots. An optional Remote Expansion Unit provides an additional 5 card slots, which can contain up to 75 input points.

The SPEEDOMAX 25000 accepts analog, discrete or pulse type input signals from the process. Thermocouple, RTD and Pulse inputs are directly accepted, with no need for intervening signal conditioning. Process signal leads are connected directly to terminal boards at the rear of the case.

All of the user-selected input data can be displayed or printed. Data may also be used in calculations and the calculated results handled the same as other data. Calculations may utilize special formulas, or any of the computational algorithms which are resident in the SPEEDOMAX 25000. Inasmuch as the chart-printing, display and alarm scanning functions are independent, they operate at their own speeds. One is not limited by the speed of the others.

In normal operation, the SPEEDOMAX 25000 Recorder scans all its analog inputs (up to 135) once every second for alarms. During the scanning "pass", a high-speed alarm comparator detects any reading in alarm status and alerts the operator on both the visual display and the printed record. The instrument displays the data in large, clear alphanumeric characters. Although the print, display and scanning functions are independent of each other, they rely on a common database. Whether printed or displayed, the data is the same. Also, because the three functions are independent of each other, you can select the *amount of data* (i.e., specific points), the *times of presentation* (i.e., durations and intervals), and the format of each. Furthermore, data can be divided into as many as 20 groups for convenient grouping of similar points. The groups may be printed sequentially or combined.

In addition to its ability to process both analog and digital inputs and outputs, the SPEEDOMAX 25000 also provides unusually powerful calculation ability. This includes a large selection of *"pseudo point"* math calculations. Pseudo points can be displayed, logged, trend-recorded and alarmed the same as analog inputs.



Safety shield prevents accidental contact with I/O cards.

Optional hand-held Programming Keyboard can be conveniently stored inside the recorder or elsewhere for greater security.

Plug-in power supply module is easily accessible.

Fuse

Plug-in I/O cards accept either analog, discrete or pulse signals from the process. TC, RTD and pulse inputs do not require signal conditioning.

ON/OFF Switch

Chart drive motor advances chart at user-selectable speeds from 1 to 200 cm/hr in increments of 1 cm/hr.

Rear of terminal strips are connected directly to plug-in I/O cards; require no internal connection by customer

Slots for 4 I/O cards in the basic recorder to accomodate up to 60 points. An optional Expansion Unit provides 5 additional card slots for up to 75 points.

Rugged, gasketed, detachable door effectively keeps out dust; swings open to 180⁰

The major features of the SPEEDOMAX 25000 Recorder—flexible alphanumeric display, recording/logging, high-speed alarm scanning, and an exceptionally powerful mathematics package—combine to give you maximum information about your process; information *you yourself select* for relative significance, timeliness and easy interpretation.

COMMUNICATIONS

The SPEEDOMAX® 25000 can be supplied with an optional Communications Card allowing single or dual port communications using RS-232 and RS-422/485 links. These communications links can be made to a variety of devices either locally connected on a multi-drop link of up to 2000′, or on a remote telephone link using modems via RS-232. DATAVUE™ Software for the IBM AT is available for custom reports, historical trending and interactive graphics to be developed for virtually any application. When the SPEEDOMAX 25000 is linked to a host computer or control system, most of the operator's functions become available under remote control. In addition, the host has the ability to re-configure the recorder; i.e., ranges, groups, alarms, etc., to meet changes that have occured in the process. The SPEEDOMAX 25000 and MICROMAX can be used together to form a very versatile data acquisition system.

OPERATION

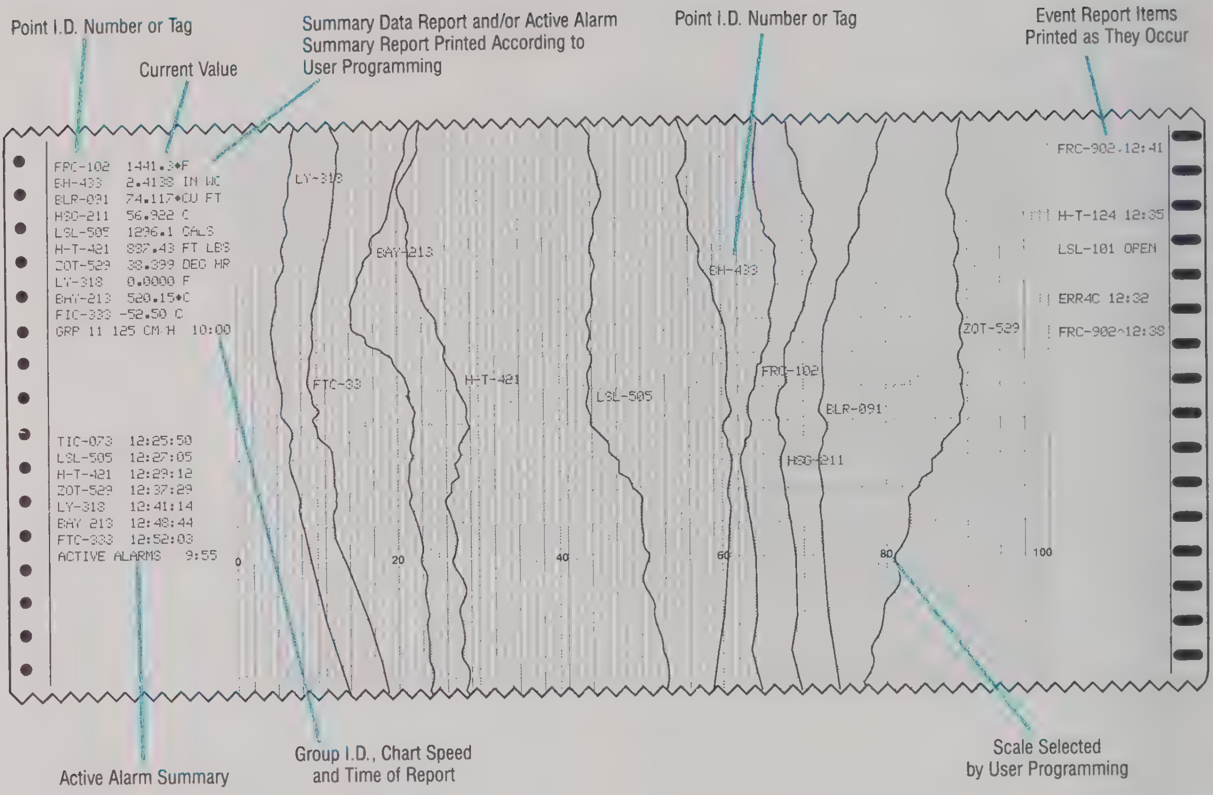
Recording/Logging Capability

The SPEEDOMAX 25000 utilizes a 9-pin, 4-color impact print mechanism and fanfold chart paper with preprinted divisions and time lines. The chart is illuminated by an internal fluorescent lamp for improved visibility. Chart speeds are selectable from 1-200 cm/hr in 1 cm/hr increments. Printing rate adapts automatically to chart speed. Two pre-programmed chart speeds can be selected via the Operator's Keyboard. An alarm can be programmed to activate the high-speed mode.

The recorder incorporates two distinct modes of operation using the single unique multi-color printing system. One is an *Analog Trend* mode which records all user-selected inputs, including pseudo points and discrete events, as continuous lines on a chart. It is an advancement of the traditional multipoint recorder. The other is a *Log* mode which prints tabular lists of user-selected process data. It operates similar to a high-speed data logger. Based on your selection of points to be recorded, the SPEEDOMAX 25000 can print out the Trend and Log modes at time intervals you select. In addition to the Trend and Log modes, the instrument also prints active alarms, times, summaries, diagnostics and other data in the left or right margins of the fan-fold strip chart, automatically or on demand.

Leeds & Northrup

Trend Mode



Typical trend chart for a 10-point group. Actual overall width of chart illustrated is 35 cm (13¾"). Operator can select either Point or Tag identification (Tag ID shown). Events in Right margin are color coded; red, alarm in; green, alarm out; blue, diagnostic message. All other items printed in black.

When operating in the Trend mode, the SPEEDOMAX 25000 produces far more and greater detailed data than any other multipoint recorder can. Here are some of its unusual features:

- **Scale Printing**—Where other multi-point recorders have 1,2, or 3 fixed scales, the SPEEDOMAX 25000 can give you as many as 135 separate scales. These include full scales and up to 3 split scales. The split scaling feature allows division of the chart into 2 or 3 sections with a different group and scale for each. The scales, with *your* graduations, descriptors, engineering units and assigned values, are printed automatically on the fan-fold strip chart at programmed intervals.

  You can assign one point or as many as required per scale.

- **Multi-Color**—You can select one of four colors—red, blue, green or black—for any printout or colors can be selected on a point or group basis. Thus, any group of variables—alarms, type of measurement, location on process, etc.—can be recognized easily.

- **Continuous Line**—There are no gaps in the trend "lines" printed by the SPEEDOMAX 25000. Although the printhead prints a series of dots, the dots are tangent to each other so you see a solid line.

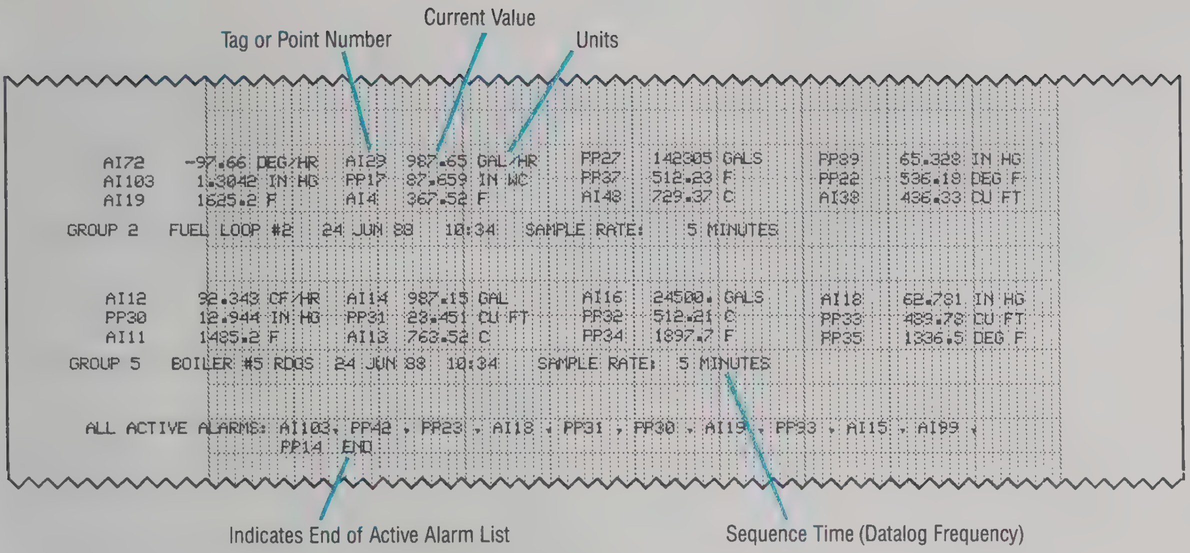
  During the printing pass, a *"dot-filling"* procedure fills the gap based on the previous value stored in memory. As a result, the printed line always matches the changing variable.

- **TRENDVUE™ Printing**—In ordinary strip chart recorders, the most recent line segments are hidden from view by the print mechanism, curvature of the chart paper or edge of the window. In TRENDVUE printing, the chart paper is automatically advanced by 60° to eliminate any visual obstruction between print cycles so you can see the current printing clearly.

- **Zoom**—Touch a key and the SPEEDOMAX 25000 "zooms-in" to expand to full scale a narrow scale segment defined by the operator. A new scale representing the enlarged area is printed along with the measured-variable trend line. This feature is extremely useful if overprinting of trend lines becomes confusing.

- **Point Hold**—To continuously track a critical point on the display and/or chart, just press a key and the SPEEDOMAX 25000 will "lock in" on a single variable. It will also automatically print the appropriate point scale. While in "Hold", the recorder will continue to monitor all other points once a second for alarms.

Log Mode


Tag or Point Number
Current Value
Units
Indicates End of Active Alarm List
Sequence Time (Datalog Frequency)

```
      AI72     -97.66 DEG/HR   AI29   987.65 GAL/HR     PP27    142305 GALS      PP89     65.328 IN HG
      AI103     1.3042 IN HG   PP17   87.659 IN WC      PP37    512.23 F         PP22     536.18 DEG F
      AI19      1625.2 F       AI4    367.52 F          AI48    729.37 C         AI38     436.33 CU FT
   GROUP 2   FUEL LOOP #2   24 JUN 88   10:34   SAMPLE RATE:    5 MINUTES


      AI12      92.343 CF/HR   AI14   987.15 GAL        AI16    24500. GALS      AI18     62.781 IN HG
      PP30      12.944 IN HG   PP31   23.451 CU FT      PP32    512.21 C         PP33     483.78 CU FT
      AI11      1485.2 F       AI13   763.52 C          PP34    1897.7 F         PP35     1336.5 DEG F
   GROUP 5   BOILER #5 RDGS  24 JUN 88  10:34    SAMPLE RATE:  5 MINUTES


    ALL ACTIVE ALARMS: AI103, PP42 , PP23 , AI18 , PP31 , PP30 , AI19 , PP33 , AI15 , AI99 ,
                       PP14  END
```

Typical datalog chart for two 12-point groups. Illustration is shown half size. Operator can select either point or tag identification. (Point ID shown.)

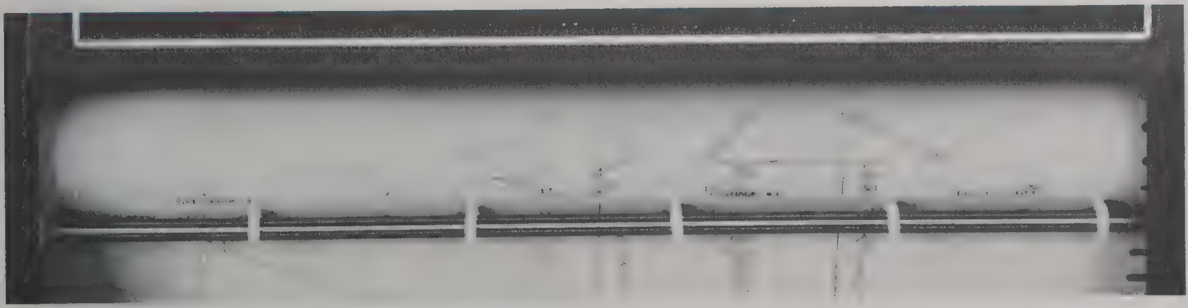
Operating in the Log mode, the SPEEDOMAX 25000 functions as a very versatile high-speed data logger. You select the points you want to log, including Pseudo Points and discrete events. You also select your own 7-character tag and 14-character descriptor for each point. You can log specific points, groups of points, active alarms, etc. The typical examples shown here suggest the wide variety of log formats available for your use.

Summary Reports

In addition to printing Datalog and Trend formats, the SPEEDOMAX 25000 prints a family of summary reports selected by the operator. Certain summaries are printed in the left or right margins of the chart, others across its full width. Listed in tabular format, the following reports are available:

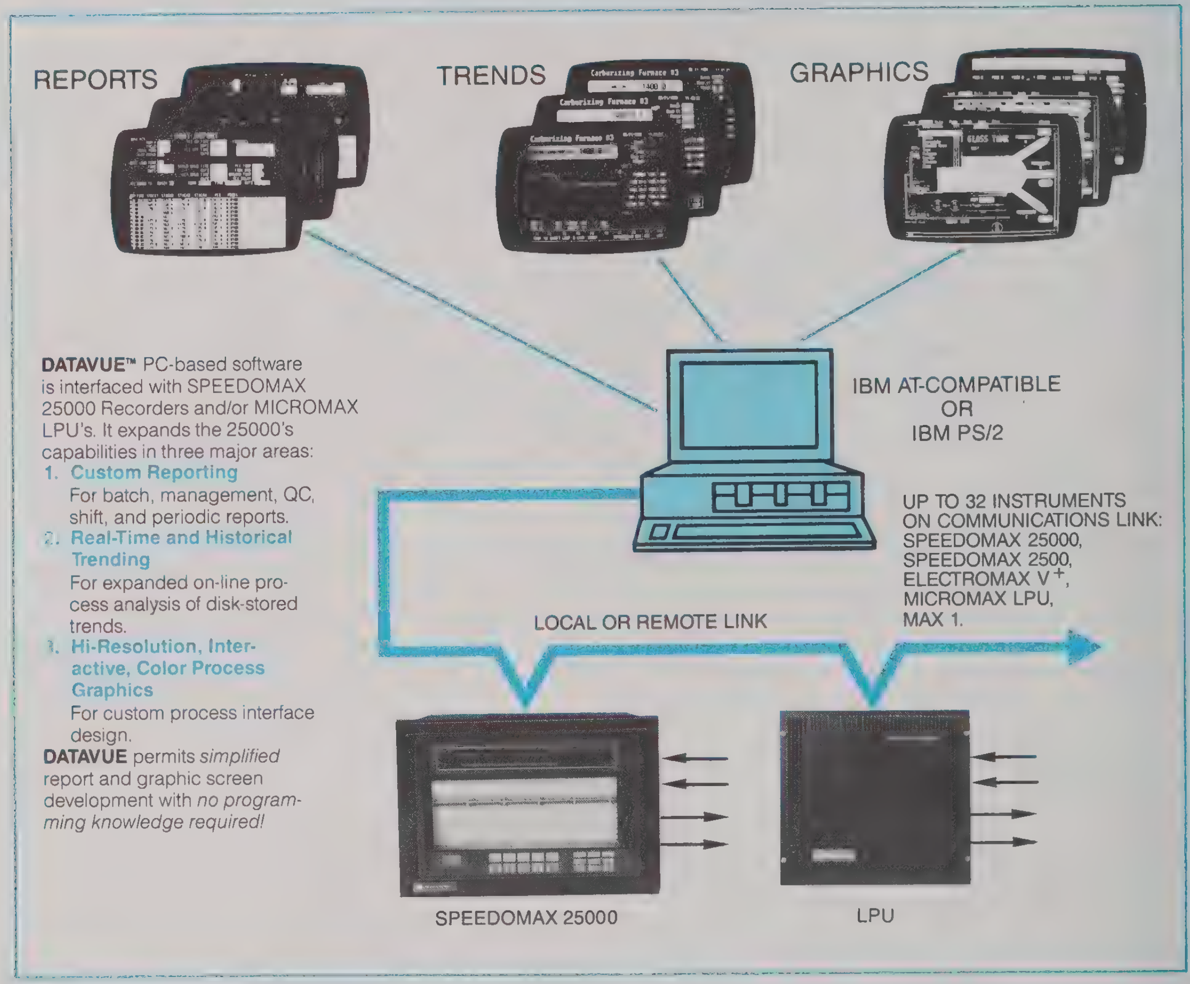
Configuration Prints out all programming functions of the recorder.
Analog Left margin listing of all analog values.
Alarm Summary Left margin listing of all active and historical alarms.
Active Alarm Right margin summary of points in active alarm.
Group Summary of all values in a group including Analog Inputs (AI), Analog Outputs (AO), Digital Inputs (DI), Digital Outputs (DO), Pseudo Points-Analog (PP), Pseudo Points-Discrete (PD), and Mathematical Constants (CN).
Events Right margin summary of current event status.
Diagnostic Right margin report of diagnostics, since power-up, that have not been deleted.

TRENDVUE™



Unique TRENDVUE feature advances the chart paper 60° following each print cycle so the latest printing is clearly visible. The paper is then retracted to the proper print position at the start of the next print cycle.

DATAVUE™ PC-Based Software



DATAVUE™ PC-based software is interfaced with SPEEDOMAX 25000 Recorders and/or MICROMAX LPU's. It expands the 25000's capabilities in three major areas:

1. **Custom Reporting**
   For batch, management, QC, shift, and periodic reports.
2. **Real-Time and Historical Trending**
   For expanded on-line process analysis of disk-stored trends.
3. **Hi-Resolution, Interactive, Color Process Graphics**
   For custom process interface design.

DATAVUE permits *simplified* report and graphic screen development with *no programming knowledge required!*

Major Features of SPEEDOMAX/ DATAVUE Network:

- **Supports instrument networking** Provides data access to multiple recorders and LPU's via an RS-485 network.
- **Standard PC hardware support** IBM "AT" compatible or IBM PS/2 hardware plus DOS, no special hardware/software additions.
- **On-line data archiving** DIF converted data files can be archived to diskette for off-line analysis using spreadsheet software such as LOTUS 1-2-3.
- **Icon library** Placement, sizing and rotating of standard icons such as valves, pumps, tanks and bar charts simplifies screen design, or build your own and save in library.
- **Flexible graphics screen animation** Bar charts for any shape, moving variable indicators, color changes, messages, blinking, and sound are easily created to show process changes or alert the operator.
- **Free placement of trend graphs** A trend graph can be sized to be anywhere on screen.
- **Flexible operator interface design** Create screen hiearchy and operator/screen interaction using redefinable function keys or "hot spots" and user-defined ENTER fields sensitive to mouse or cursor selection.
- **On-line editing/backgrounding of report trend data** Data acquisition to disk files is independent of DOS allowing on-line screen editing without data loss.
- **Pixel-resolution process graphics** Use 16 colors for EGA or VGA graphics to pixel resolution.
- **Flexible alarming** The latest two alarm messages can be placed anywhere on screens; also standard alarm summary/history screens provided.
- **On-screen floating point calculations** For screen animation or reporting of dynamic data from multiple recorders.
- **Graphic printout** Print any graphic screen with colors represented in shades of gray.
- **Power fail recovery** Data collection continues for trends and reports after power loss.
- **On-line labelling screens** For parameter tags, descriptors, and on-off labels.
- **Security** Password protection for editing function, create your own for parameter entry.

DATAVUE is a comprehensive PC-based software package that complements the reporting, trending, and alarming capabilities of the SPEEDOMAX 25000 Recorder. It also expands the operator interface to the realm of high-resolution, interactive process graphics. Mouse-driven screen development utilizing pull-down menus and windowed parameter lists allow you to design screens quickly without any programming knowledge. A DATAVUE software package is available in two versions: Reports/Trends offering no graphics drawing capability, or Reports/Trends/Graphics offering all of the package features.

The versatility of DATAVUE's software can range from pure data acquisition and process analysis utilizing custom report formats and trends to complete supervision of processes through high resolution process graphic displays and menu lists. Its high-speed link to multiple SPEEDOMAX 25000's and MICROMAX LPU's using a standard PC serial communications port offers real-time access to process data for monitoring only, or for interactive control of process loops and parameter changes from any screen. Since DATAVUE accesses data from the optional communication port it can be assigned a task totally independent of the SPEEDOMAX 25000 offering process recording redundancy.

Data collection for reports and trends is run as a background task independent of DOS. This allows screens to be developed or edited concurrently without loss of important process data. Data stored to a disk file can be converted on-line to a DIF format, then archived to a floppy disk allowing the data to be analyzed off-line using spreadsheet software.

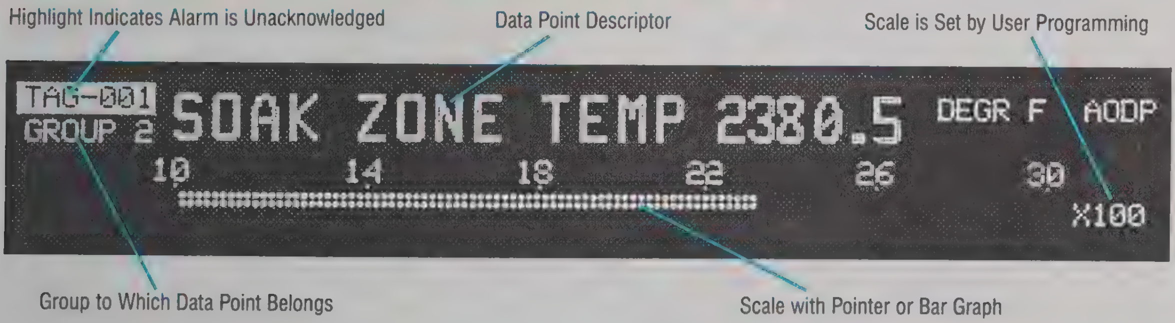
DATAVUE also lets you get on-line quickly. For data acquisition predrawn templates of data bar graph and trend formats are provided.

Display Capability

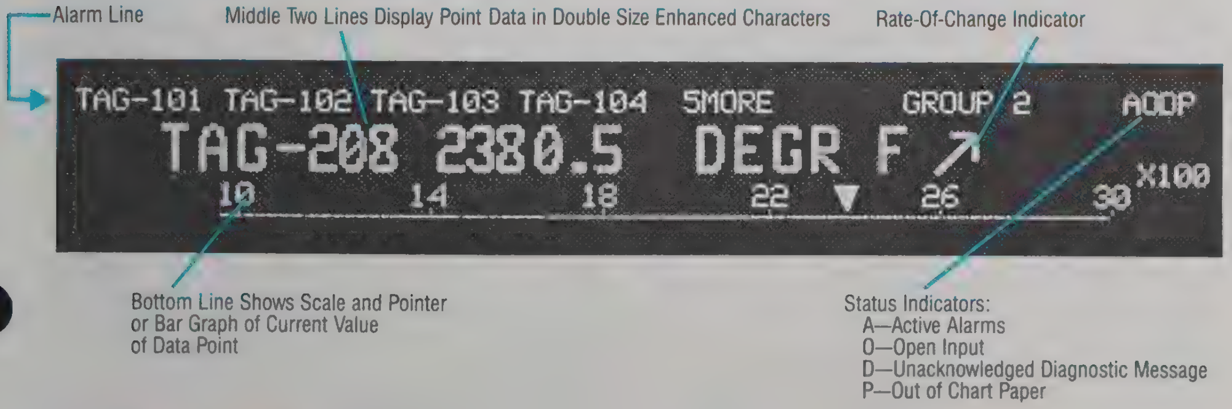
A major feature of the SPEEDOMAX 25000 Recorder is its unique display function. At the touch of a button, the operator can see—among many selectable displays—either a bold bar graph or pointer with an appropriate analog scale; a Rate-Of-Change arrow (↑ ↗ ↘ ↓) showing 10% or 20% change; 15 points displayed simultaneously; up to 4 active alarms; a user-selected 14-character descriptor; and many more items.

The display panel is a bright orange dot matrix plasma type with an approximate viewing area of 1-¼″ × 12″ (40 × 384 pixels). It offers both high visibility alphanumeric and graphic capability. Completely independent of printing or alarm scanning, the display can be programmed to display selectable points at speeds from 1 second to one minute, or any point or points can be displayed on demand. All points can be displayed sequentially or grouped and displayed sequentially within the group. A group can include up to 30 points, with a maximum of 20 groups assigned in the recorder. The process data you can display in a selection of 9 formats are described in the following illustrations of typical displays.

Format 3: Analog Point, Descriptor with Scale & Bar Graph

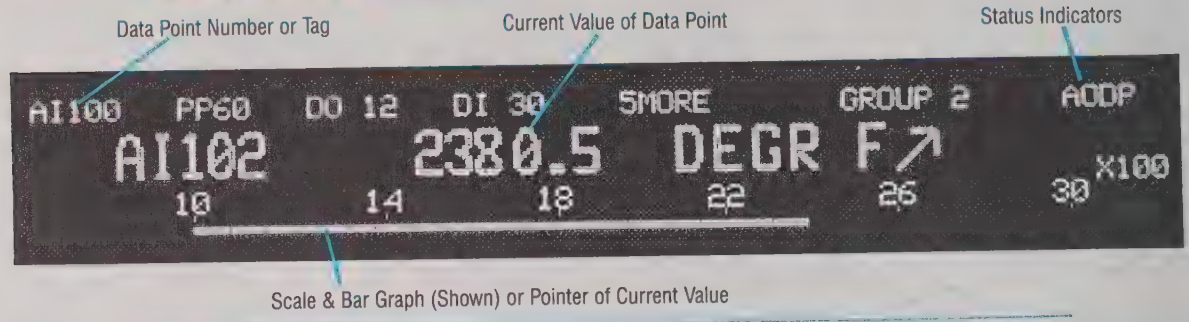

Highlight Indicates Alarm is Unacknowledged
Data Point Descriptor
Scale is Set by User Programming
TAG-001
GROUP 2
SOAK ZONE TEMP 2380.5
DEGR F
AODP
10
14
18
22
26
30
X100
Group to Which Data Point Belongs
Scale with Pointer or Bar Graph

Format 4: Analog Point, Tag I.D. with Scale & Pointer, Alarm Line & Rate-Of-Change Indicator

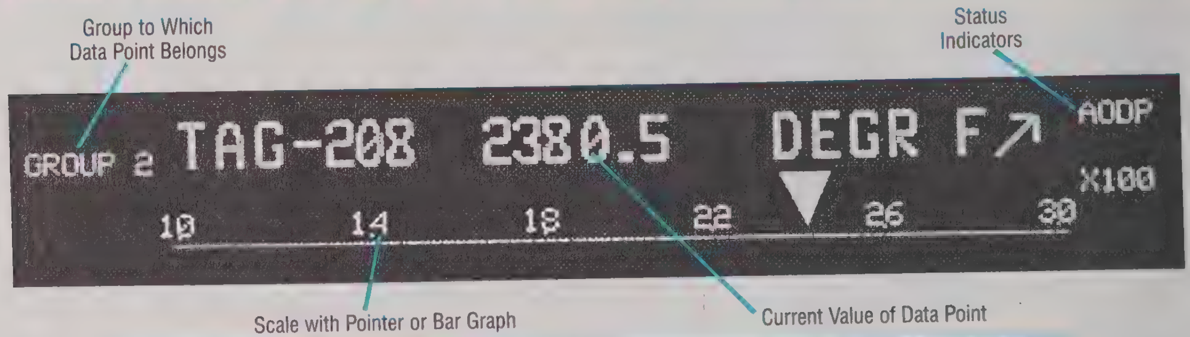

Alarm Line
Middle Two Lines Display Point Data in Double Size Enhanced Characters
Rate-Of-Change Indicator
TAG-101 TAG-102 TAG-103 TAG-104 5MORE
GROUP 2
AODP
TAG-208 2380.5 DEGR F ↗
10
14
18
22
26
30
X100
Bottom Line Shows Scale and Pointer or Bar Graph of Current Value of Data Point
Status Indicators:
A—Active Alarms
O—Open Input
D—Unacknowledged Diagnostic Message
P—Out of Chart Paper

Display Capability continued

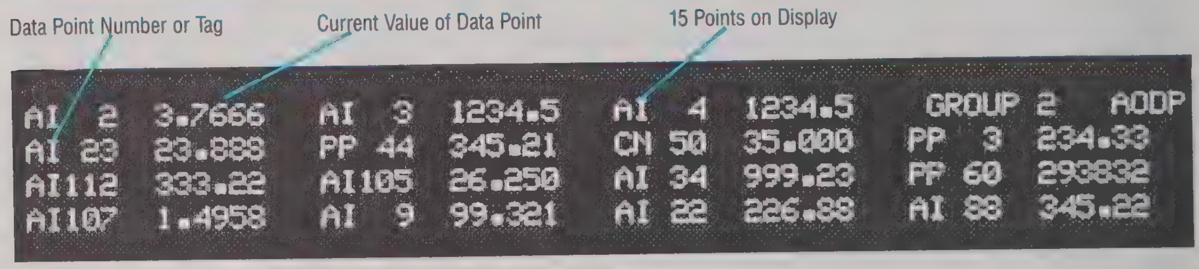
Format 5: Analog Point, Point I.D. with Scale & Bar Graph, Alarm Line & Rate-Of-Change Indicator


Data Point Number or Tag
Current Value of Data Point
Status Indicators
AI100 PP60 DO 12 DI 30 5MORE GROUP 2 AODP
AI102 2380.5 DEGR F↗
X100
10 14 18 22 26 30
Scale & Bar Graph (Shown) or Pointer of Current Value

Format 6: Analog Point, Tag I.D. with Scale, Large Pointer & Rate-Of-Change Indicator


Group to Which Data Point Belongs
Status Indicators
GROUP 2 TAG-208 2380.5 DEGR F↗ AODP
X100
10 14 18 22 26 30
Scale with Pointer or Bar Graph
Current Value of Data Point

Format 8: Analog Points, Point I.D., 15 Points Displayed Simultaneously


Data Point Number or Tag
Current Value of Data Point
15 Points on Display
AI 2 3.7666 AI 3 1234.5 AI 4 1234.5 GROUP 2 AODP
AI 23 23.888 PP 44 345.21 CN 50 35.000 PP 3 234.33
AI112 333.22 AI105 26.250 AI 34 999.23 PP 60 293832
AI107 1.4958 AI 9 99.321 AI 22 226.88 AI 88 345.22

Pseudo Points

Another unique feature of the SPEEDOMAX 25000 Recorder is its ability to compute up to 60 pseudo points in addition to 135 inputs/outputs and 50 constants. A pseudo point is a data point whose value is derived from the values and relationships of other data points, constants, mathematical or logical expressions. The SPEEDOMAX 25000 *computes* all pseudo points every second. Each pseudo point can be assigned a tag and point identification, scanned for alarm conditions, displayed and recorded in context with all other data points.

There are presently 27 pre-programmed functions and 10 math functions available to choose from when setting up a pseudo point.

Pre-programmed calculations:

- Scale
- Signal Select
- Signal Clamp
- Low Select
- High Select
- Boiler Drum Level
- Compare—Equal
- Compare—Less Than
- Compare—Greater Than
- Compare—Less/Equal
- Scaled Square Root
- Single Input Time Averaging
- Multiple Input Averaging up to 25 inputs
- Single Input Deviation
- Multiple Input Deviation
- Totalization—Hours
- Totalization—Minutes
- Mass Flow / Square Root
- Compare—Greater/Equal
- Time Compare
- Logic "And"
- Logic "Or"
- Logic "XOR"
- Logic "Not"
- Peak Picking—High
- Peak Picking—Low
- Rate of Change

Math Functions:

- Add
- Subtract
- Multiply
- Divide
- Square Root
- Log x
- Ln x
- e^x
- y^x
- Absolute Value
- 20 Variables and 10 parentheses per equation

The pre-programmed calculations can be combined with math functions to satisfy virtually any complex application.

Alarm Capability

When configuring the SPEEDOMAX 25000, you can assign an individual alarm to virtually any desired parameter. The parameter may be an input analog or discrete or other data point or combination of data points, or a calculated value or combination of calculated values. The alarm can be set to recognize changes in values, whether measured or calculated, and changes in state, including logic states. Because individual alarms can also be linked together in logical AND or OR relationships, alarms can be tailored with great flexiblility to monitor the complex interacting relationships of a process.

Alarms can be selected for up to *five* different alarm actions (High, Low, High Rate, Low Rate, and Deviation). There are a maximum of 120 alarms that can be assigned. Set points can be fixed or variable as well as the result of a programmed pseudo point.

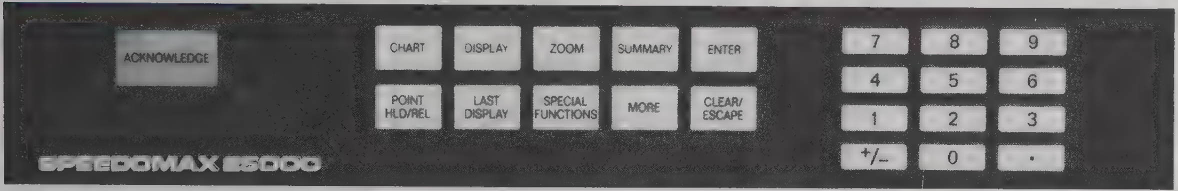
When an alarm occurs, the following responses can be selected:

- Log (print) on alarm, all points in group.
- Log (print) on alarm, alarm point only.
- Switch chart speed up to higher speed.
- Display alarm points (annunciate).
- Switch a discrete output relay on or off.

Alarms can be displayed and printed on occurance and when cleared. All alarms are reported on the chart and on the display with descriptive information. The information includes parameter I.D. and value, alarm limit, and reference I/O descriptions. Reportable events, open inputs, and diagnostic messages are similarly reported when they occur and when they clear. If desired, alarms can be used for annunciation only (i.e., "soft" alarms).

All 120 alarm levels are scanned every second to determine off normal conditions.

Keyboards



The Operator Keyboard, built into the front of the instrument, has dedicated keys and requires entry of a 4-character code to prevent unauthorized access to certain functions. This Keyboard is also available in a multi-language version.

To enhance both the operation and convenience of the SPEEDOMAX 25000 Recorder, *two* keyboards are available: one, a simplified *Operator's Keyboard* is built into the front of the instrument; the other, a plug-in, hand-held *Programming Keyboard* can be stored inside the recorder or elsewhere for added security. Additionally, an IBM-format (PC, AT) keyboard may also be used for programming. Programming is fully menu-driven with display prompts to guide each step. A "Copy" function reduces the need for repetitive keyboard data entry. Configuration data is stored in battery-backed RAM.

The SPEEDOMAX 25000 can be configured by either a plug-in, hand-held Programming Keyboard or an IBM-format (PC-AT) keyboard. The keyboards are available as accessories. A sturdy receptacle, built into the front of the recorder, will accept either keyboard directly. The hand-held keyboard can be conventiently stored inside the recorder or elsewhere for added security.

Diagnostic Capability

The SPEEDOMAX 25000 provides a comprehensive package of built-in diagnostic capabilities. Self-diagnosis procedures are performed automatically and continuously at power-up and during operation. In addition, other diagnostic routines can be programmed from the keyboard for detailed diagnosis.

If a problem occurs, the SPEEDOMAX 25000 automatically records the appropriate diagnostic information (error code, time and date) and indicates the presence of a diagnostic message to the operator. Up to 50 messages can be retained in the recorder's memory. These can be displayed individually or printed in summary on the chart.

Security

Programmable multilevel codes can be used to restrict operator access. Code entry is required for all programming activities and selected operator functions.

Application Versatility

The SPEEDOMAX 25000 Hybrid Recorder is a true *multi-function* instrument. Each function—display, trend recording, data logging, high-speed background alarm scanning, math calculating—gives you the versatility to use the recorder creatively in a variety of ways. You can use each of its functions independently or collectively; simultaneously, concurrently, serially or periodically. For example, here are some of the ways you can apply the SPEEDOMAX 25000 to your process:

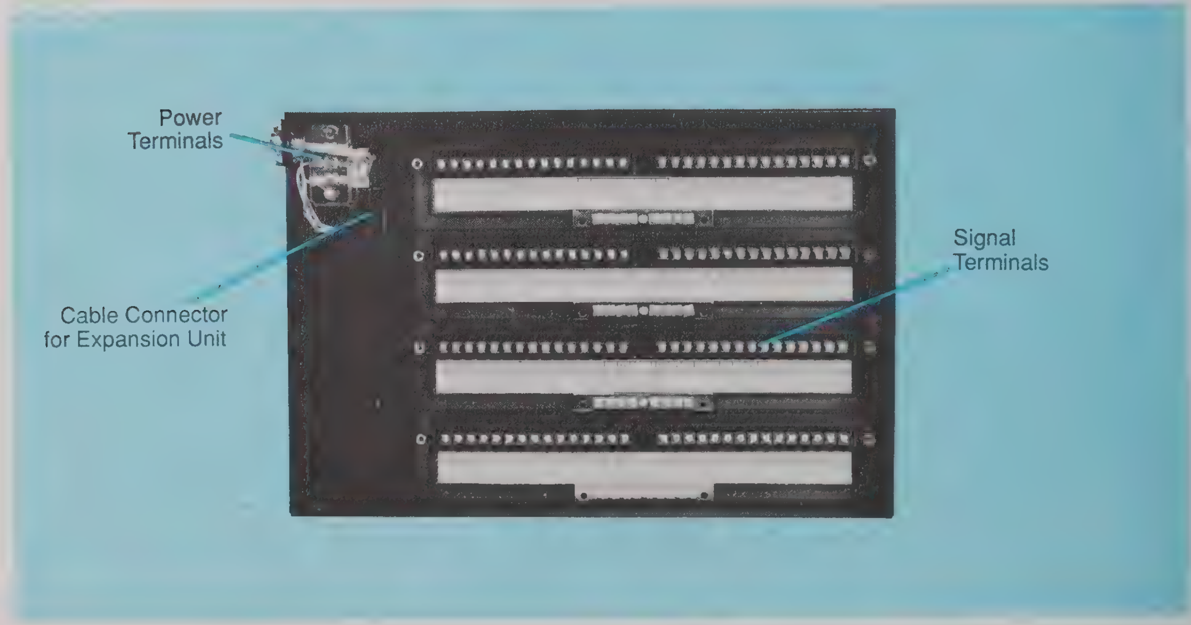
- Trend Recording
- Multipoint-Multigroup Recording
- Sequential Recording
- Event Recording
- Data Logging
- Process Validation Reporting
- Quality Control Tracking
- Efficiency Calculating & Reporting
- Etc.

Formerly, you would have needed a bank of recorders plus a higher-priced data acquisition system to produce the results you can now get with a single SPEEDOMAX 25000 Hybrid Multi-Function Recorder.

Convenient Installation & Maintenance

Installation and maintenance of the SPEEDOMAX 25000 are fast and easy. The recorder is clamped in place through a panel cutout and requires no drilled holes. Its gasketed door, which swings open a full 180°, is easily removable, and the entire internal chassis swings out to provide easy access to the components in the rear of the case.

All electrical connections are made at terminal strips, easily accessible on the rear of the recorder. Chart paper is easily loaded merely by placing it in a tray and feeding the leading edge over a drive roll. The 4-color printer ribbon, supplied in a disposable cartridge, is simply placed between spring-loaded levers and snapped into place. Paper and ribbon replacement can be done without interrupting the high-speed alarm scanning or display functions of the recorder. Maintenance is further reduced by the use of multiple microprocessors, a floating point math co-processor and stepper motors instead of slidewires and servos.



All customer electrical connections are made at appropriately labeled terminal strips easily accessible on the rear of the recorder. The terminals will accept up to 12-gauge wire and are protected by a dust-tight access cover (not shown).

Specifications

Recorder

Performance: Meets or exceeds performance requirements of ANSI C39.4.
Safety: Meets or exceeds requirements of ANSI C39.5.
Chart: Preprinted pack, 35 cm × 8 cm fanfold × 30 meters long.
Chart Speeds: All chart speeds are metric. Selectable from 1-200 cm/hr in 1 cm/hr increments.
Display:
Type: Gas plasma dot matrix.
Resolution: 32 pixels/inch.
Color: Orange.
Size: 1¼″ × 12″ (40 × 384 pixels).

Keyboard:
Operator's: Membrane switch panel.
Programmer's: Custom hand-held membrane switch panel or IBM AT type.
Update (Scan) Rate: All inputs, pseudo points, etc. are scanned in 1 second for alarms, etc.
Non-Volatile Memory: Battery backed RAM.
Battery type: Lithium.
Battery life: 2 years.
Environmental:
Temperature: Operation, −5 to 50° C.
Storage: −30 to +70° C.
Humidity: 10-90% RH, non-condensing.
Power Requirements: 120 VAC (95-135V) 60 Hz, 220/240 VAC (190-270V) 50/60 Hz, one side neutral. Consumption 100 VA. Must be ordered from factory as 50 Hz or 60 Hz and 120, 220 or 240 VAC. Field conversion is not possible.
Weight: 60 lb. maximum.
Dimensions: 17.9″ W x 12.3″ H x 17.2″ D (depth measured from front of panel).
Mounting: Panel, rack, table top.

Expansion Unit

Maximum Number of Cards: 5.
Environmental:
Temperature: Operation, −10 to +55℃.
Storage: −30 to +70℃.
Humidity: 10-90% RH, non-condensing.
Power Requirements: 120 VAC nominal +10% −15%, 60 Hz, 40 VA average.
220/240 VAC nominal +10% −15%, 60/50 Hz.
Weight: 45 lbs. maximum.
Dimensions: 19.0″ W x 17.5″ H x 14.8″D.

Analog Input Cards

Input Types: Thermocouple, mV, V, mA (via shunt) and radiation sensors.
Current Inputs: Use terminal board mounted shunt resistors (ordered and supplied separately).
Range Suppression: Limits not imposed.
Input Impedance: 20 megohms.
Maximum Source Resistance: 15K ohm (8 point card is 1K ohm).
Souce Effects: 0.3 microvolts/100 ohms.
Point to Point Isolation: 200 Volts peak.
Common Mode Rejection: 120 dB (100 ohm source, 100V max.), 50 or 60 Hz.
Normal Mode Rejection: 60 dB (50 or 60 Hz, 100% span max.)
Input Switching: Low thermal reed relay, 500 million operations rating.
Open Input Check: Selectable on per point basis for thermocouples. Open inputs are indicated in the right hand chart margin. Open input can be set to trigger an alarm.

Ranges/Accuracy:

	Range	Card Type		Accuracy* (25±2°C for 1 Yr.)	Resolution
		10/15 Point	8 Point		
V	Selectable Range between −2.000V and +5.0000V. Minimum Span. 10mV	X		±0.1% of reading for Zero Accuracy. See Zero Accuracy table below.	.01%
V	Hi level, selectable (between −2.000V and +10.000V), Minimum Span 4.0V		X	±0.1% +4mV	.01%
TC	E −450 to 2200°F −267 to 1200°C J −350 to 2190°F −212 to 1195°C K −450 to 2800°F −267 to 1535°C T −450 to 760°F −267 to 400°C N −8 to 2372°F 0 to 1300°C W5-W26 0 to 3980°F −18 to 2194°C Plat II −100 to 2500°F −74 to 1372°C B 300 to 4540°F 149 to 2504°C R −50 to 3210°F −45 to 1765°C S −50 to 3640°F −45 to 2004°C	X		±0.1% of reading for Zero Accuracy. See table below	0.01% for ranges below 999.9 .01% for ranges above 999.9.
	Radiation Ranges	X		(See Rayotube and Spectray Table)	

can be calibrated to ±0.01% of reading (or display resolution)

Zero Accuracy:

High End of Range (in millivolts)	Zero Accuracy (in millivolts)
0 – 10	±15
10 – 25	±20
25 – 50	±30
50 – 100	±60
100 – 150	±100
250 – 500	±200
500 – 1000	±500
1000 – 2500	±1000
2500 – 5000	±2000

Reference Junction Error: 0.3 °C (0.5 °F).

Conformity Error: 0.3 °C (0.5 °F).

Rtd Input Card

Type: 10 point, 3 lead.
Input Types: 10 ohm copper, 100 ohm platinum (alpha=.00385 ohm/ohm/℃), 1000 ohm platinum (alpha=.00375 ohm/ohm/℃).

Input Type	Range	Accuracy
Cu, 10 ohm	−50° to +150° C	±0.15% + .30° C
Pt, 100 ohm	−180° to +850° C	±0.15% + .30° C
Pt, 1000 ohm	−184° to +537° C	±0.15% + .30° C

Input Type	Resolution
Cu, 10 ohm	0.1°, thru
Pt, 100 ohm	999.9, 1°
Pt, 1000 ohm	above 999.9

(continued)

Specifications continued

Conformity Error: 0.3° C (0.5° F).
Temperature Stability: 1.5 microvolts/° C.
Excitation Current: 1 mA.
Maximum Compensation for Lead Resistance: 5 ohm.
Point to Point Isolation: 200 Volts peak.
Input Switching: Low thermal reed relay, 500 million operations rating.
Common Mode Rejection: 120 dB (100 ohm source, 100V max.), 50 or 60 Hz.
Normal Mode Rejection: 60 dB (50 or 60 Hz, 100% span maximum)

Rayotube and Spectray Ranges

1. 18890 RAYOTUBE®	**~1—24 MV**
2. 18894/18899 RAYOTUBE®	**~ 0—10 mV**
3. Spectray®	**~ 0—125 mV (18885 / 18886)**
4. Fiberay®	**1—5 V**
5. 18874 / 18875 RAYOTUBE®	**1—5 V**

Pulse Input Card

No. of Inputs: 5.
Frequency Range: 10 Hz to 10 KHz pulse rate.
Input Level:

1) 5 volt - sine to square wave
   "0" level < 1.0V
   "1" level 3.5 to 6.5V
   Current 1.6 mA source
2) 24 volt - sine to square wave
   "0" level < 1.0V
   "1" level 5 to 30V
3) Open collector-customer supplied voltage and pullup resistor

Duty Cycle: 40 to 60%.
Input Type: DC coupled floating isolated input.
Accuracy: 1 pulse per update period.
Minimum Pulse Width: 0.1 ms.
Input Isolation: Point to point, point to ground, optical.

Discrete Inputs/Outputs

All SSR (Solid-State Relay) discrete input/output cards use single plug-in modules (Potter & Brumfield Opto-22, or equivalent) for each point. Isolation of all solid-state relay modules is 4 KVRMS, input to output. All SSR output modules are individually fused.

15 point AC Input
Voltage Range: 90 to 140 VAC
Input Current: 12mA maximum
Turn On/Off Time: 20 ms

15 point DC Input
Voltage Range: 10 to 32 VDC
Input Current: 35 mA maximum
Turn On/Off Time: 5 ms

10 point AC Output
Voltage Range: 24 to 280 VAC
Current Rating: 1 A
Surge Current for 1 Cycle (16 ms): 15A.
Minimum Current: 20 mA
Switching: Zero-crossing

10 point DC Output
Voltage Range: 5 to 60 VDC
Current Rating: 1 A
Turn-On Time: 500 microseconds
Turn-Off Time: 750 microseconds

10 point Relay Output
Type: SPDT Form C relays, plug-in
Contact Rating: 1A Maximum (3A for selected relays with a maximum of 70A for any Local Processing Unit or Expansion Unit) at 120/240 VAC

7 point AC Input/8 point AC Output
AC Inputs: 90 to 140 VAC/DC
AC Outputs: 24 to 280 VAC @ 1 A.
Surge Current for 1 cycle (16 ms): 15 A.

7 point DC Input/8 point DC Output
DC Inputs—10 to 32 VDC/AC
DC Outputs—5 to 60 VDC @ 1 A

7 point DC Input/8 point DC Output
DC Inputs—10 to 32 VDC/AC
DC Outputs—5 to 200 VDC

Analog Outputs

Output Base Card Capacity: 2 to 8 retransmission outputs (4 dual output cards).

Function: Retransmission of analog inputs, calculations, function block outputs.

Type: Dual Voltage Output.

Isolation: Dual output card to dual output card, 480 VRMS.

Dual Voltage Output Card:

Outputs/Card: 2 (independent).

Isolation: Input to output, 240 VRMS.

Range: 0 to 5V, 0 to 10V at 10 mA maximum

Resolution: 0.025%.

Communications Card

Communication Ports: Single and dual port cards.
Data Link: RS-232 (maximum length 50′) or RS-422/485 (maximum length 2000′ multi-drop) customer selectable per port. Remote modem linking via RS-232.
Protocol: Models after X3.28.
Data Rate: Selectable 1200, 9600, 19.2K baud.
Parity: Odd, even, or none.
Commands Available: Most operator functions, data read/write, recorder configuration.
Drivers Avaiable: MICROMAX® Management Station Direct RS-422 link; DATAVUE™ Software running on IBM 286/386-AT machines (see Data Sheet GO.0003-DS); DEC-VAX/VMS using MAXCOM Interface; US DATA Factory Link® MAX 1 Distributed Control System.

Specifications Subject to Change Without Notice

LEEDS & NORTHRUP North Wales, PA 19454
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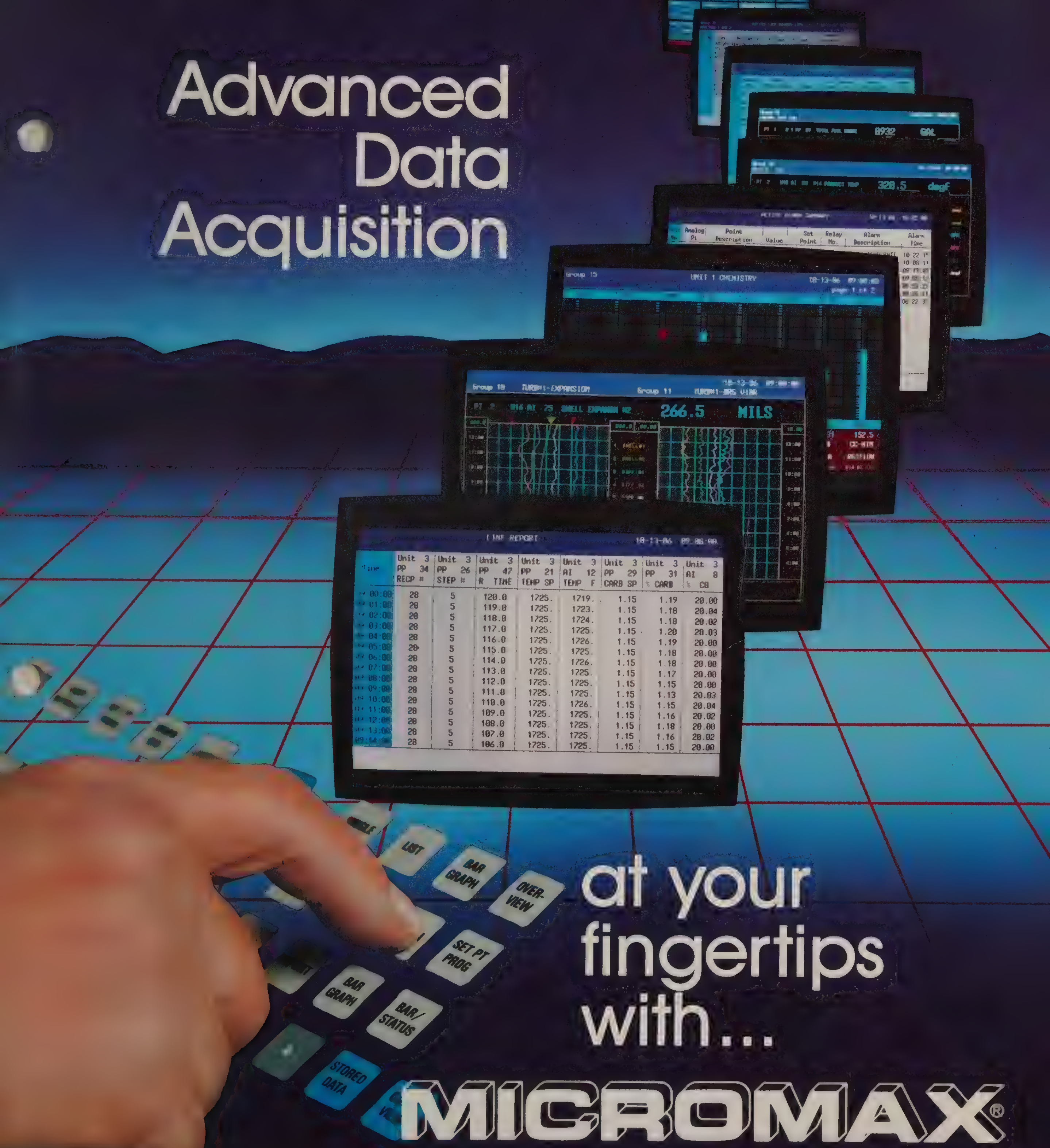
Advanced Data Acquisition


UNIT 1 CHEMISTRY
TURB#1-EXPANSION
266.5
MILS
LIST
BAR GRAPH
OVER-VIEW
SET PT PROG
BAR GRAPH
BAR/STATUS
STORED DATA

LINE REPORT 10-13-86

Time	Unit 3 PP 34 RECP #	Unit 3 PP 26 STEP #	Unit 3 PP 47 R TIME	Unit 3 PP 21 TEMP SP	Unit 3 AI 12 TEMP F	Unit 3 PP 29 CARB SP	Unit 3 PP 31 % CARB	Unit 3 AI 8 % CO
00:00	28	5	120.0	1725.	1719.	1.15	1.19	20.00
01:00	28	5	119.0	1725.	1723.	1.15	1.18	20.04
02:00	28	5	118.0	1725.	1724.	1.15	1.18	20.02
03:00	28	5	117.0	1725.	1725.	1.15	1.20	20.03
04:00	28	5	116.0	1725.	1726.	1.15	1.19	20.00
05:00	28	5	115.0	1725.	1725.	1.15	1.18	20.00
06:00	28	5	114.0	1725.	1726.	1.15	1.18	20.00
07:00	28	5	113.0	1725.	1725.	1.15	1.17	20.00
08:00	28	5	112.0	1725.	1725.	1.15	1.15	20.00
09:00	28	5	111.0	1725.	1725.	1.15	1.13	20.03
10:00	28	5	110.0	1725.	1726.	1.15	1.15	20.04
11:00	28	5	109.0	1725.	1725.	1.15	1.16	20.02
12:00	28	5	108.0	1725.	1725.	1.15	1.18	20.00
13:00	28	5	107.0	1725.	1725.	1.15	1.16	20.02
09:14	28	5	106.0	1725.	1725.	1.15	1.15	20.00

at your fingertips with...

MICROMAX®

Data Management Center

LEEDS & NORTHRUP
A UNIT OF GENERAL SIGNAL

Instrument and System Solutions!

MICROMAX Data Managemen

Gives you a reliable, versatile, inexpensive data acquisition capability . . . and a head start toward total plant automation!

Leeds & Northrup's MICROMAX Data Management Center gives you new capabilities for obtaining process data faster—data that's more up-to-date and easier to obtain than ever before.

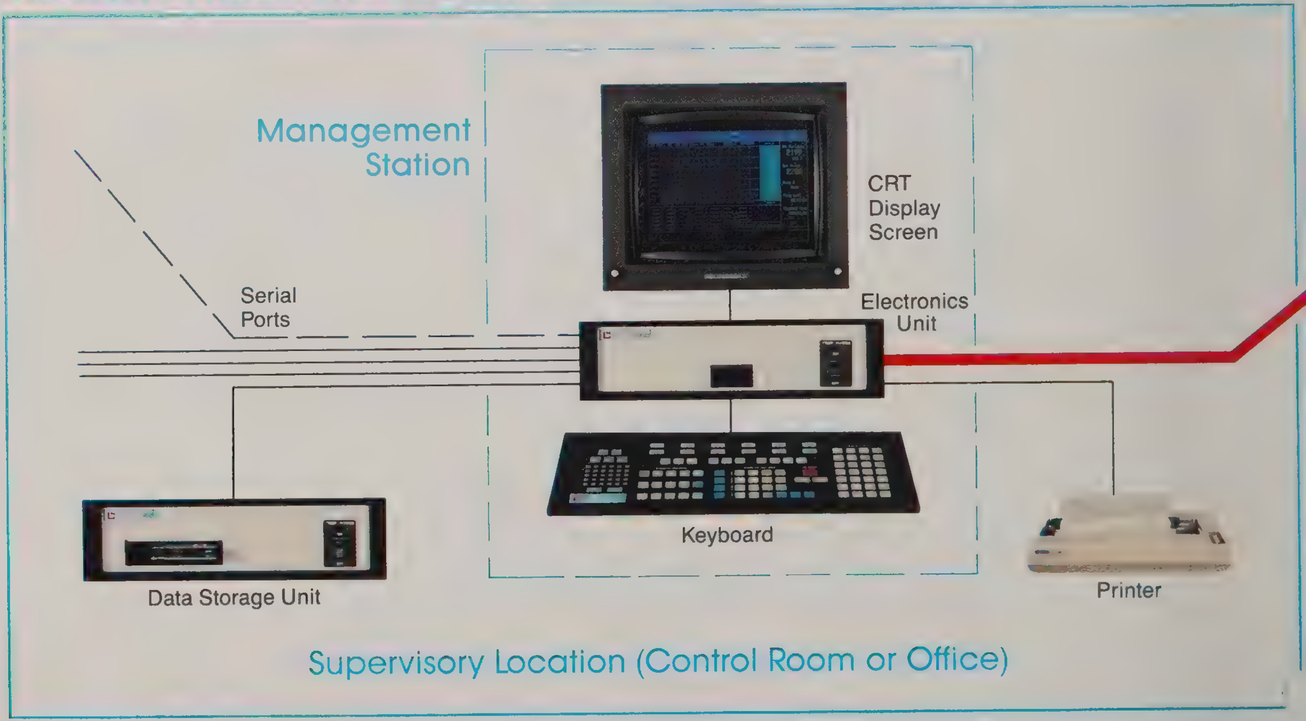
For example, MICROMAX far outperforms strip-chart recorders that track as few as 75 points yet it costs little more than an ordinary data logger. But there's really no comparison when it comes to its *total* capabilities.

To start with, the MICROMAX display uses a 16-color high resolution videoscreen that shows a wide variety of graphic presentations, including various strip-chart formats. Here, management reports can be displayed in either standard or user-configured formats. You get an extensive list of math functions for computations, including averaging, group averaging, comparisons, sums, and many more.

Easy to store and retrieve data

Your process inputs, representing temperatures, pressures, flows, etc., are directly accepted by MICROMAX. You can scan points or calculated values for alarms. After the initial programming via simple "fill-in-the-blanks" menus, process data is easily scheduled to printers or tape cartridges for long-term archiving. You can archive data in realtime or in compressed form using replaceable streaming tape cartridges. With MICROMAX, information is more-accessible to you. Furthermore, you can easily reduce the volume of data and your data archiving facilities. In short, the added value you get from a MICROMAX Data Management Center makes it far more cost-effective for data acquisition than any other approach available today.

MICROMAX Data Management Center-Basic Data Acquisition



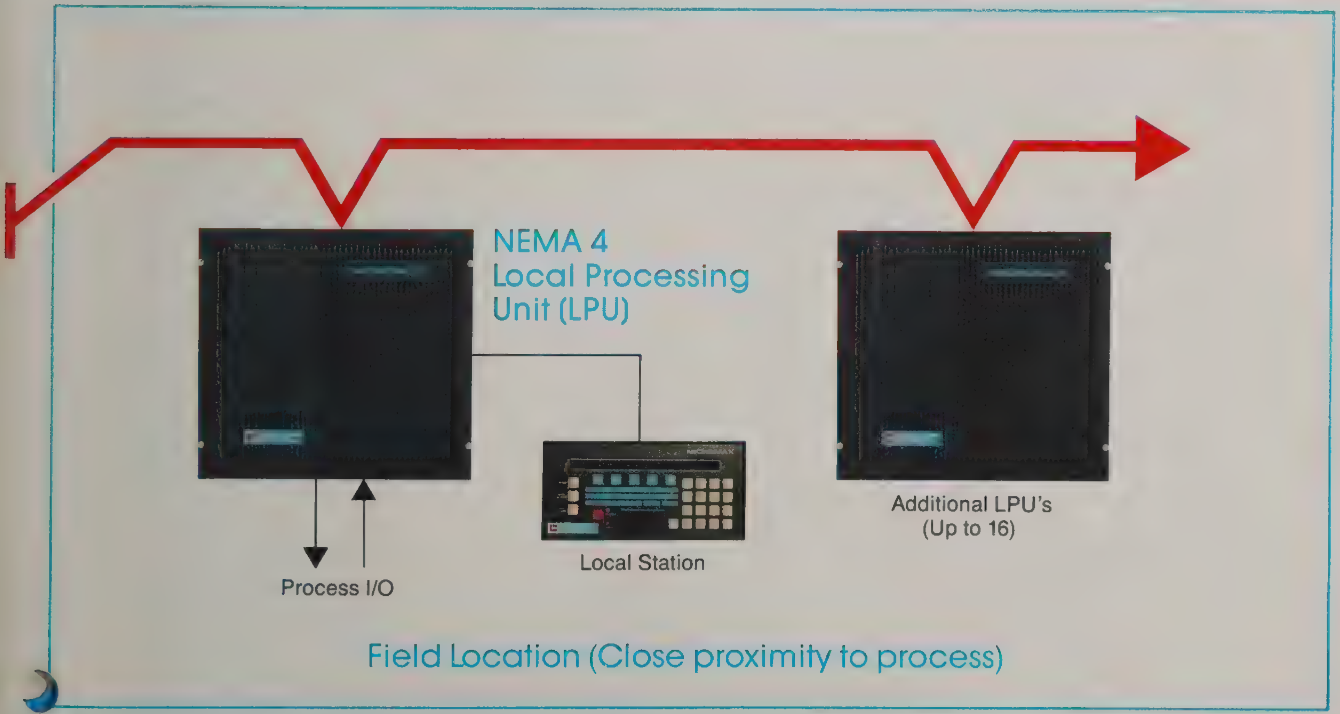
A basic MICROMAX System consists of only two components: a Management Station and a Local Processing Unit. The Management Station can be located in the Engineering or Operations office or Control Room. The Local Processing Unit—in a NEMA 4 case—is located on the process floor. A single 5-conductor cable is all that's required

Center

Major Features

- High-speed scanning; 1050 points scanned within ¾ second, maximum.
- Integral reporting capabilities; no need for a computer.
- Communication interfaces to other devices.
- Distributed Architecture: Field-mounted NEMA 4 Local Processing Unit (LPU) connected to centrally-located Management Station via a single cable; reduces installation costs.
- Superior operator interface via 16-color high resolution CRT and dedicated keyboard keys.
- Easy to program—"fill in the blanks"; custom software not required.
- Auxiliary supervisory stations available to provide additional "windows" to process.
- Accepts process inputs directly: TCs, RTDs, milliamps, volts, millivolts, pulse, discrete (ac/dc).
- Robust calculation capability: averaging, group averaging, math, input selects, etc. (Used in reports, trends, etc.)
- Alarming on any point or calculated value; high, low, rate of change, deviation.
- Large capacity data storage unit: 10 MByte hard disk, 60 MByte streaming tape; data compression routines.
- Interface to existing SPEEDOMAX® 1650/2500 Multipoint Recorders.
- Local indication/alarm-acknowledge through Local Station.

...and more!



to connect the Management Station to the field-mounted LPU. A variety of communication links and peripherals is available for enhancement or future expansion. One or two convenient

Local Stations can be connected to each LPU for operator use at the process.

Management Station

a highly efficient interface to your process.

Consisting of a Keyboard, electronics unit and CRT display, your Management Station can be conveniently located on a table top or mounted in a panel or console.

Basically, a MICROMAX Data Management Center is composed of a Management Station and one or more Local Processing Units. Centrally located in your office or control room, the MICROMAX Management Station provides a highly efficient man/machine interface to configure the data acquisition scheme for your process. It communicates with Local Processing Units over a multi-drop serial data link. It collects process information, organizes it into meaningful data categories and presents the data to you on its CRT screen in a variety of display or printout formats for easy comprehension. You can access both current and historical process data to enable you to evaluate process performance and take corrective action when required. The Management Station is also used to configure each Local Processing Unit for its intended purpose.

Local Processing Unit

built to work in a rugged industrial environment

The MICROMAX Local Processing Unit (LPU) is the core of the system and is physically separate from the Management Station. You can locate it close to your point of measurement, remote from your office or control room. Although the LPU is configured through the Management Station, it operates completely independently of the Management Station once it has been configured.

High installation costs avoided

The LPU is designed to be located right at the process. It is housed in a rugged, watertight and dust-tight (NEMA-4) case and built to operate over a temperature range of −10C to +55C (+14F to 131F). Behind its bolt-on cover is a removable card cage that gives you ready access to heavy-duty terminal boards which directly accept field wiring of up to 14-gage wire. Thermocouples, RTD's and pulse signals are accepted directly without any intervening signal conditioning. For speed and ease in servicing, you can remove all printed circuit cards from the rear of the swing-out chassis without removing the input connections. With MICROMAX, you avoid high installation cost because of shorter wiring runs, eliminating junction boxes, the avoidance of signal conditioning, and use of only a single cable between the LPU and Management Station.

LPU in dusttight, watertight, NEMA-4 housing can be mounted right at your process; needs only short wiring runs to nearby sensors.

Data Storage Unit

lets you store and retrieve process data at will …in the format of your choice.

An optional Data Storage Unit gives you the capability to store data on a historical basis and to maintain backup copies of configuration programs stored in the Management Station. You can store short-term historical information such as trends of data gathered over the past eight hours (as compared to current trend data), on a 10-megabyte hard disk. There is also a 60-megabyte removable tape cartridge that enables you to store data as archival information or as a backup to the hard disk. With MICROMAX, you'll be able to maintain large volumes of clear, precise records over time. In addition, MICROMAX saves storage space and gives you quicker recall.

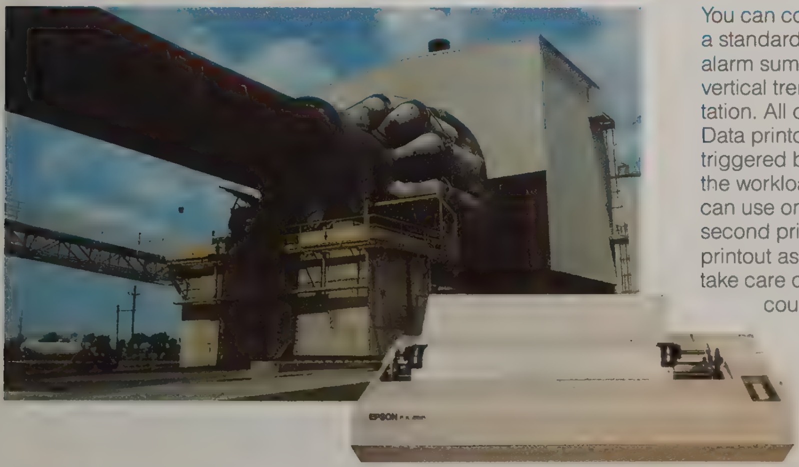
Compress data into meaningful samples

You can store data in its entirety or by exception or, for greater efficiency, compress it into meaningful samples. Data compression can take the form of periodic samples, averaged values over a specified time period, averages plus high and low readings, values which are deviations from setpoint, etc., enabling you to archive critical process information faster.

Recall data quicker
Stored data is readily retrievable from either a disk or tape cartridge for display in a selection of formats. For example, once stored, information can be presented on any screen you desire such as a 24-point tabular report, a vertical-recorder trend, a horizontal trend, a bar chart or a tabular list. You can then produce a printout of the display to document the information being reviewed.

The MICROMAX Data Storage Unit expands the utility of your Management Station; lets you easily store and quickly retrieve historical process information.

Printers give you a variety of hard copy.

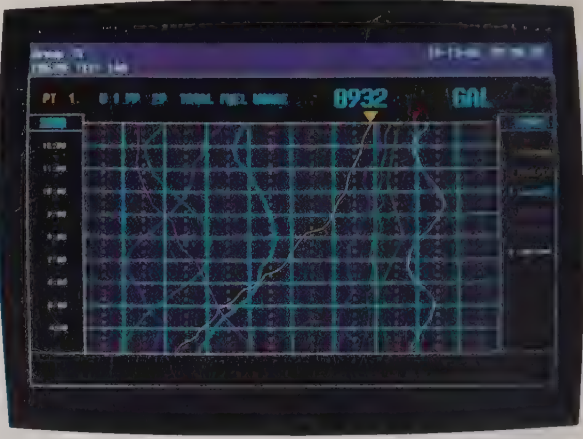


You can connect an Epson FX286 dot matrix printer to a standard parallel interface to obtain alarm recording, alarm summaries, periodic logs, logs on demand, vertical trends, custom reports and program documentation. All display screens may be printed on demand. Data printouts may take place on a time schedule or be triggered by an event without operator intervention. If the workload becomes too great for a single printer, you can use one of the optional serial ports to connect a second printer to the Management Station to share printout assignments. For example, one printer could take care of all report logging while the second printer could be dedicated exclusively to alarm logging.

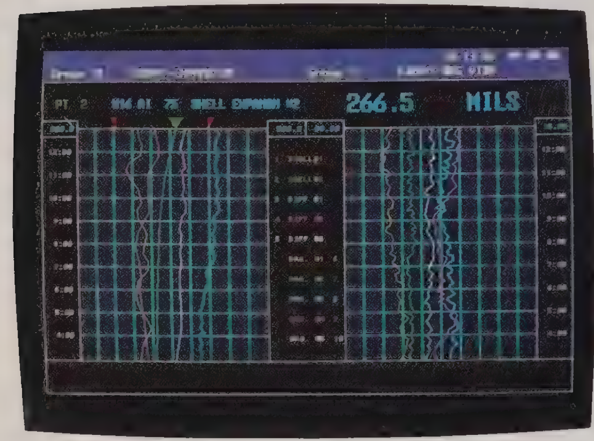
To obtain hard copies of data, you can connect one or two wide-carriage, dot matrix printers to your Management Station

A variety of screen displays and printouts give you a good look at your operations.

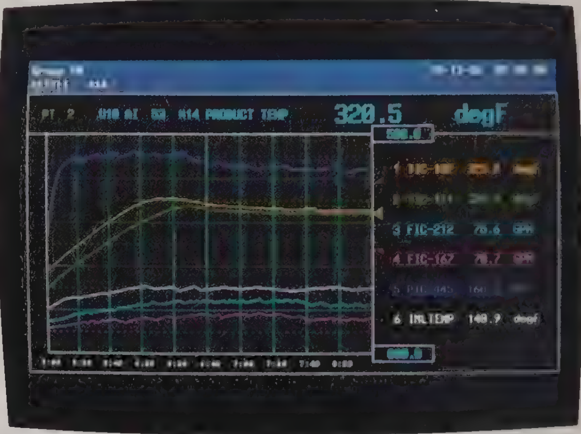
You get a closer, cleaner view of process dynamics through the windows of a variety of MICROMAX displays and printouts. Pictured here are a number of typical formats available for your information-management and reporting functions. Screens and reports can be displayed by the operator on the CRT or printed out.


PT 1.
TOTAL FUEL USAGE
0932
GAL

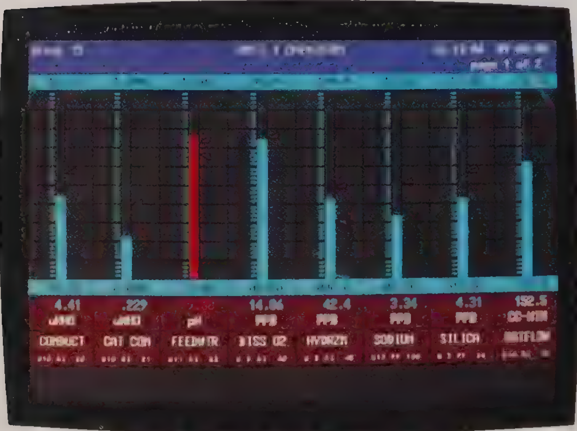
With only one or two keystrokes, you can select a vertical trend format that emulates a strip-chart recorder.


PT 2
SHELL EXPANSN
266.5
MILS

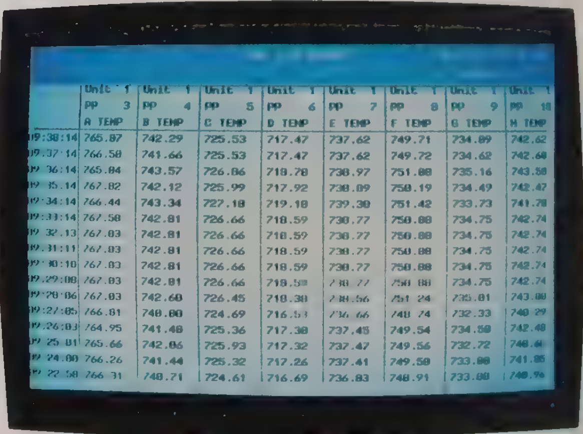
You can select recorder formats such as a dual scale (shown) or a triple scale to aid in grouping related point data.


PT 2
U10 AI 58 N14 PRODUCT TEMP
320.5
degF
3 FIC-212 76.6
4 FIC-167 78.7
6 INLTEMP 140.9 degF

Up to 6 points can be trended in a horizontal format.

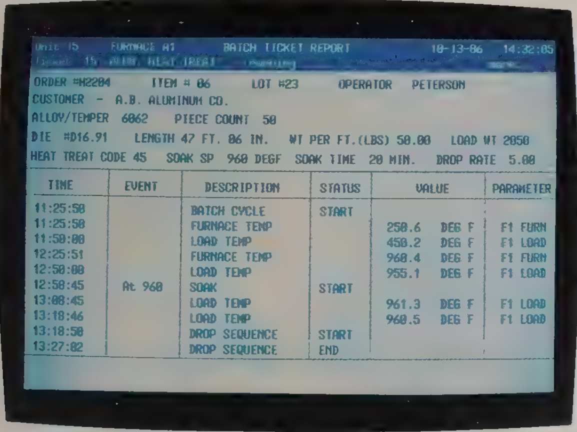

page 1 of 2
4.41
.229
14.86
42.4
3.34
4.31
152.5
pH
PPB
PPB
PPB
PPB
CONDUCT
CAT CON
FEEDWTR
DISS O2
HYDRZN
SODIUM
SILICA
AIRFLOW

Highly visible bar graph display shows up to 8 current values with alarm points.



	Unit 1 PP 3 A TEMP	Unit 1 PP 4 B TEMP	Unit 1 PP 5 C TEMP	Unit 1 PP 6 D TEMP	Unit 1 PP 7 E TEMP	Unit 1 PP 8 F TEMP	Unit 1 PP 9 G TEMP	Unit 1 PP 10 H TEMP
9:38:14	765.87	742.29	725.53	717.47	737.62	749.71	734.09	742.62
9:37:14	766.50	741.66	725.53	717.47	737.62	749.72	734.62	742.60
9:36:14	765.84	743.57	726.86	718.78	738.97	751.00	735.16	743.50
9:35:14	767.82	742.12	725.99	717.92	738.09	750.19	734.49	742.47
9:34:14	766.44	743.34	727.10	719.10	739.30	751.42	733.73	741.70
9:33:14	767.50	742.81	726.66	718.59	738.77	750.00	734.75	742.74
9:32:13	767.03	742.81	726.66	718.59	738.77	750.00	734.75	742.74
9:31:11	767.03	742.81	726.66	718.59	738.77	750.00	734.75	742.74
9:30:10	767.03	742.81	726.66	718.59	738.77	750.00	734.75	742.74
9:29:08	767.03	742.81	726.66	718.58	738.77	750.00	734.75	742.74
9:28:06	767.03	742.60	726.45	718.30	738.56	751.24	735.01	743.00
9:27:05	766.81	740.00	724.69	716.53	736.66	748.74	732.33	740.29
9:26:03	764.95	741.40	725.36	717.30	737.45	749.54	734.50	742.40
9:25:01	765.66	742.06	725.93	717.32	737.47	749.56	732.72	740.61
9:24:00	766.26	741.44	725.32	717.26	737.41	749.50	733.00	741.85
9:22:58	766.31	740.71	724.61	716.69	736.83	748.91	733.00	740.96

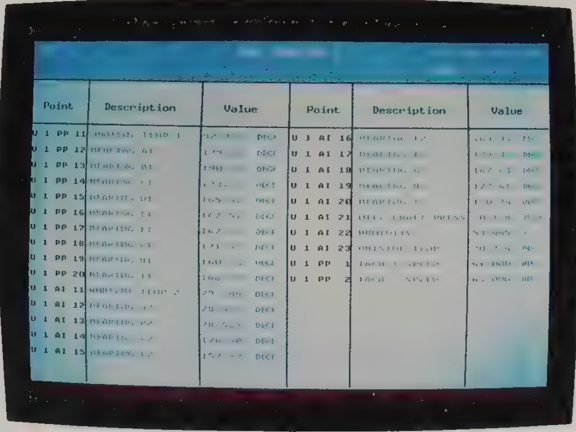
Line reports of up to 24 parameters logged at specified intervals can be displayed 8 columns at a time—you tab across the screen to view all 24 columns.



```
Unit 15     FURNACE A1          BATCH TICKET REPORT          10-13-86    14:32:05
Ticket 15  ALUM. HEAT TREAT
ORDER #H2204        ITEM # 06        LOT #23        OPERATOR    PETERSON
CUSTOMER  -  A.B. ALUMINUM CO.
ALLOY/TEMPER  6062     PIECE COUNT  50
DIE  #D16.91     LENGTH 47 FT. 06 IN.    WT PER FT.(LBS) 50.00    LOAD WT 2050
HEAT TREAT CODE 45    SOAK SP  960 DEGF   SOAK TIME  20 MIN.    DROP RATE  5.00
```

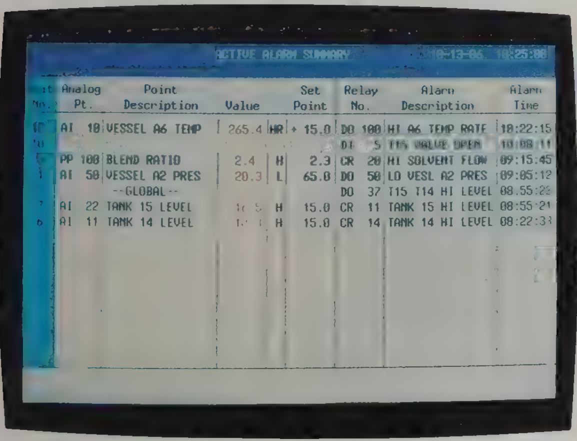
TIME	EVENT	DESCRIPTION	STATUS	VALUE	PARAMETER
11:25:50		BATCH CYCLE	START		
11:25:50		FURNACE TEMP		250.6 DEG F	F1 FURN
11:50:00		LOAD TEMP		450.2 DEG F	F1 LOAD
12:25:51		FURNACE TEMP		960.4 DEG F	F1 FURN
12:50:00		LOAD TEMP		955.1 DEG F	F1 LOAD
12:50:45	At 960	SOAK	START		
13:08:45		LOAD TEMP		961.3 DEG F	F1 LOAD
13:18:46		LOAD TEMP		960.5 DEG F	F1 LOAD
13:18:50		DROP SEQUENCE	START		
13:27:02		DROP SEQUENCE	END		

A display of a batch ticket report includes an area for user-defined batch information to identify sequentially recorded process variables and events.



Point	Description	Value	Point	Description	Value
U 1 PP 11	[illegible]	[illegible]	U 1 AI 16	[illegible]	[illegible]
U 1 PP 12	[illegible]	[illegible]	U 1 AI 17	[illegible]	[illegible]
U 1 PP 13	[illegible]	[illegible]	U 1 AI 18	[illegible]	[illegible]
U 1 PP 14	[illegible]	[illegible]	U 1 AI 19	[illegible]	[illegible]
U 1 PP 15	[illegible]	[illegible]	U 1 AI 20	[illegible]	[illegible]
U 1 PP 16	[illegible]	[illegible]	U 1 AI 21	[illegible]	[illegible]
U 1 PP 17	[illegible]	[illegible]	U 1 AI 22	[illegible]	[illegible]
U 1 PP 18	[illegible]	[illegible]	U 1 AI 23	[illegible]	[illegible]
U 1 PP 19	[illegible]	[illegible]	U 1 PP 1	[illegible]	[illegible]
U 1 PP 20	[illegible]	[illegible]	U 1 PP 2	[illegible]	[illegible]
U 1 AI 11	[illegible]	[illegible]			
U 1 AI 12	[illegible]	[illegible]			
U 1 AI 13	[illegible]	[illegible]			
U 1 AI 14	[illegible]	[illegible]			
U 1 AI 15	[illegible]	[illegible]			

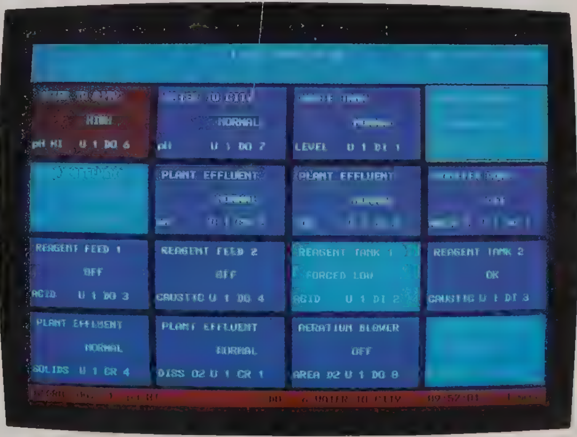
A data table provides a realtime or archival view of up to 30 parameters simultaneously.



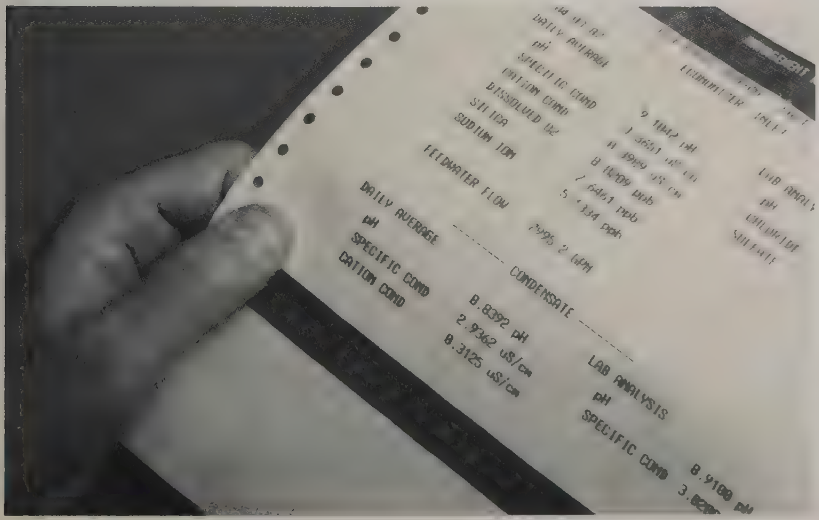
ACTIVE ALARM SUMMARY 10-13-86 10:25:00

Analog Pt.	Point Description	Value		Set Point	Relay No.	Alarm Description	Alarm Time
AI 10	VESSEL A6 TEMP	265.4	HR	+ 15.0	DO 100	HI A6 TEMP RATE	10:22:15
					DI 5	T15 VALVE OPEN	10:08:11
PP 100	BLEND RATIO	2.4	H	2.3	CR 20	HI SOLVENT FLOW	09:15:45
AI 50	VESSEL A2 PRES	20.3	L	65.0	DO 50	LO VESL A2 PRES	09:05:12
	--GLOBAL--				DO 37	T15 T14 HI LEVEL	08.55:22
AI 22	TANK 15 LEVEL	[illegible]	H	15.0	CR 11	TANK 15 HI LEVEL	08:55:21
AI 11	TANK 14 LEVEL	[illegible]	H	15.0	CR 14	TANK 14 HI LEVEL	08:22:33

Both an active alarm summary (shown) and a historical alarm summary are available to display *in a consolidated format* parameters currently in alarm or previously alarmed.


HIGH
pH HI U 1 DO 6
NORMAL
pH U 1 DO 7
LEVEL U 1 DI 1
PLANT EFFLUENT
PLANT EFFLUENT
REAGENT FEED 1
OFF
ACID U 1 DO 3
REAGENT FEED 2
OFF
CAUSTIC U 1 DO 4
REAGENT TANK 1
FORCED LOW
ACID U 1 DI 2
REAGENT TANK 2
OK
CAUSTIC U 1 DI 3
PLANT EFFLUENT
NORMAL
SOLIDS U 1 CR 4
PLANT EFFLUENT
NORMAL
DISS O2 U 1 CR 1
AERATION BLOWER
OFF
AREA O2 U 1 DO 8
WATER TO CITY
09:52:01

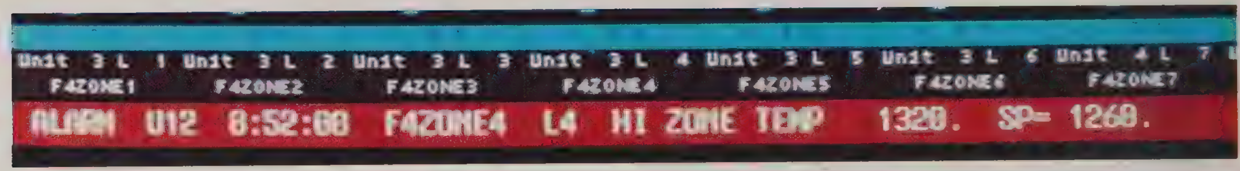
An annunciator format annunciates up to 16 events. Vivid, easily identified colors show process changes clearly.


DAILY AVERAGE
pH
SPECIFIC COND
CATION COND
DISSOLVED O2
SILICA
SODIUM ION
FEEDWATER FLOW
ECONOMIZER INLET
LAB ANALYSIS
pH
CHLORIDE
SULFATE
2995 2 GPM
DAILY AVERAGE
pH
SPECIFIC COND
CATION COND
CONDENSATE
8.8392 pH
2.9362 uS/cm
0.3125 uS/cm
LAB ANALYSIS
pH
SPECIFIC COND
8.9100 pH

All CRT display screens can be printed out on demand when a hard copy is desired. In addition, management reports and line item reports can be programmed for printout at predetermined intervals. A long-term trend report is also available which is similar to multi-point stripchart recording annotated with alarm details and other information.

Extensive Alarm Network

You can configure it to handle all situations



```
Unit  3 L  1 Unit  3 L  2 Unit  3 L  3 Unit  3 L  4 Unit  3 L  5 Unit  3 L  6 Unit  4 L  7
  F4ZONE1      F4ZONE2      F4ZONE3      F4ZONE4      F4ZONE5      F4ZONE6      F4ZONE7
ALARM  U12  8:52:00  F4ZONE4  L4  HI ZONE TEMP   1320.  SP= 1260.
```

The MICROMAX Management Station gives you alarm information of all types, including analog level, deviation, open inputs, discrete, or logically linked alarms.

To alert the operator, all alarms are announced with a flashing red stripe which appears at the bottom of any screen currently on display. At the same time they can be routed to a printer for logging.

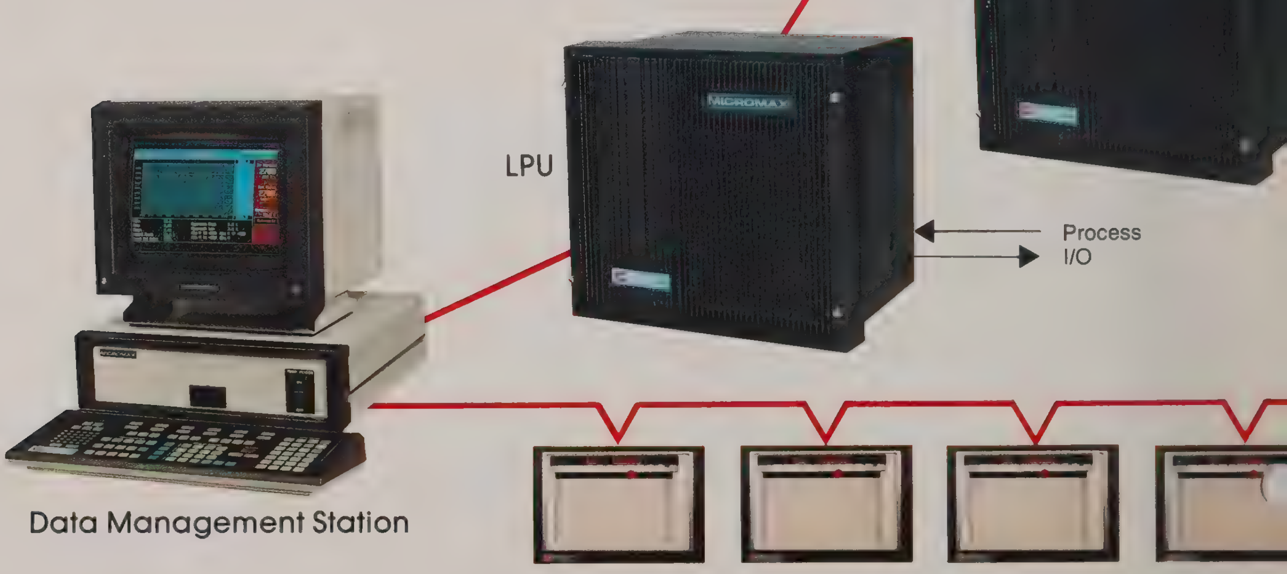
When an alarm is announced, the operator pushes an "ACKNOWLEDGE" key which stops the flashing of the red stripe. It also calls up a summary of all active alarms or a preselected target screen with associated process data. Using this information he can respond quickly to correct off-normal conditions.

For simultaneous display of *additional* color-coded messages, an area for a 2nd line is reserved on each screen (below the red Alarm stripe). These messages include reportable events (yellow), open inputs (white), and diagnostic faults (blue).

Three relays are available in the Management Station to actuate signal lights or horns in the control room. If more than three outputs are needed, an optional Global Alarm Unit provides up to 50 discrete outputs for an annunciator. Usually located near the Management Station on the primary data link, the Global Alarm Unit combines alarm conditions that you select from any of your Local Processing Units, either on an individual basis or logically linked in global AND/OR alarm groups. You can depress an Alarm Summary key at any time to view a listing of all active alarms (up to 150) or the last 50 alarms that have cleared. In addition, MICROMAX enables you to configure a comprehensive alarm network *for each application* thereby assuring a continuing high level of security for your process.

MICROMAX is completely compatible with existing instrumentation.

Where L&N Speedomax Recorders or Electromax V^{Plus} Single-Loop Controllers are already in place or are planned additions, they can be incorporated into the MICROMAX Data Management Center via serial communications to a port in the Electronics Unit. As many as 30 instruments located as far away as 1000 ft. can be accommodated on a single data link. One, two or three serial ports are available to interface MICROMAX with a host computer, one or two supervisory stations, an additional printer, or other Leeds & Northrup products not related to the MICROMAX equipment.



MICROMAX grows as your needs grow

Up to 16 LPU's

Each MICROMAX Data Management Center can be expanded to incorporate as many as 16 LPU's. As a result, you can readily extend MICROMAX to new process units as they come on line. And since all 16 LPU's can be configured and monitored from the original Management Station, the savings you'll realize from this shared overhead arrangement can be considerable.

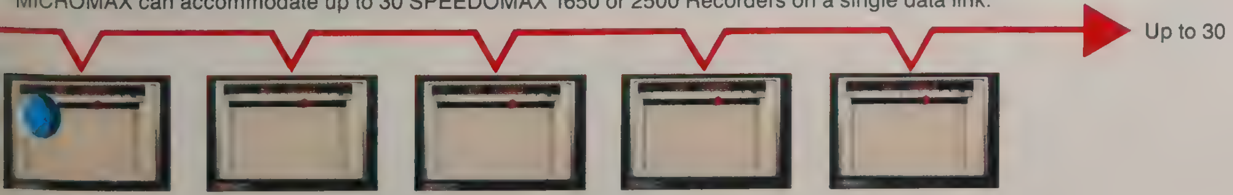
Adding Control Functions

You can easily add control functions—both loop and logic—to your MICROMAX Data Management Center at any time and with virtually no additional hardware required. Operating from a common interactive database, MICROMAX executes loop control, logic functions and data acquisition within the LPU, which is the core of the MICROMAX Process Management Center. This continuous interaction of functions gives you a degree of process control that cannot be achieved using conventional instruments.

Negligible Cost

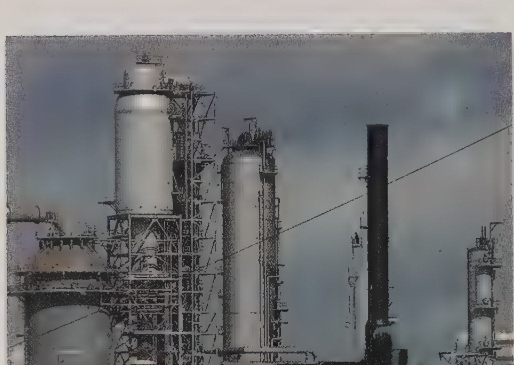
The cost of adding control to your MICROMAX Data Management Center is almost negligible. That's because of MICROMAX's soft-wired approach. With it, you can quickly and easily create from one to 64 control loops—for either a batch or continuous process. A dynamic configuration diagram displayed on the CRT screen enables you to enter various symbols and shift them around to build a control loop or system that will envelop all the variables and events needed to control the process. Logic programming is executed using standard ladder diagrams. The combination of these programming techniques gives you a truly simplified and economical method for implementing control.

MICROMAX can accommodate up to 30 SPEEDOMAX 1650 or 2500 Recorders on a single data link.



MICROMAX assures outstanding data management of any unit process.

Opportunities exist in hundreds of unit processes to realize the benefits of a MICROMAX Data Management Center. The following list of typical applications may suggest locations where MICROMAX can help you:



- **Analytical Chemistry Labs & Processes**
- **Autoclaves**
- **Boilers**
- **Chemical Reactors**

- **Digesters**
- **Distillation Columns**
- **Environmental Test Chambers**
- **Fermenters**

- **Food Processing**
- **Furnaces/Ovens/ Kilns**

Look at MICROMAX Today.

Investigate.

See for yourself how effective, inexpensive-to-install and easy-to-use a MICROMAX Data Management Center can be for *your* process.

Start small.

You can install the smallest MICROMAX Data Management Center in your plant—a Management Station and a Local Processing Unit. Use it to increase your knowledge of your process dynamics. At the same time, your operators can become comfortable with the CRT interface and MICROMAX keyboard.

Throw away your clipboards

With MICROMAX you'll get faster, more timely, more dependable and more meaningful data than ever before. . . in the exact format you need.

- Process Monitoring
- Temperature Profiling
- Turbine/Generator Monitoring

- Glass Tanks & Feeders
- Papermaking Machines
- Performance Analysis
- Pilot Plants

and many more.

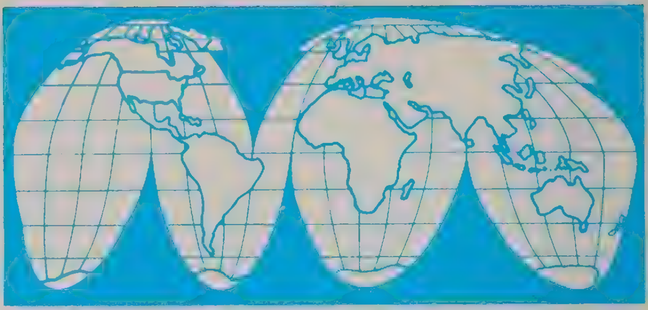
Expand to desk-top centralized control.

For a small added investment in the same MICROMAX Data Acquisition hardware, you can easily add loop and logic control at any time. That's because MICROMAX uses a common interactive database for all *three* functions—data acquisition, loop and logic control. This gives you the highest degree of centralized process control attainable—right at your fingertips—control supported by timely, accurate, automatically compiled data—all from the same small, economical instrument-facility: your MICROMAX Process Management Center.

Call for more information.

Take the next step now. Contact your nearest Leeds & Northrup Sales Office or Representative for detailed information or to arrange a demonstration.

Worldwide Organization to Serve You



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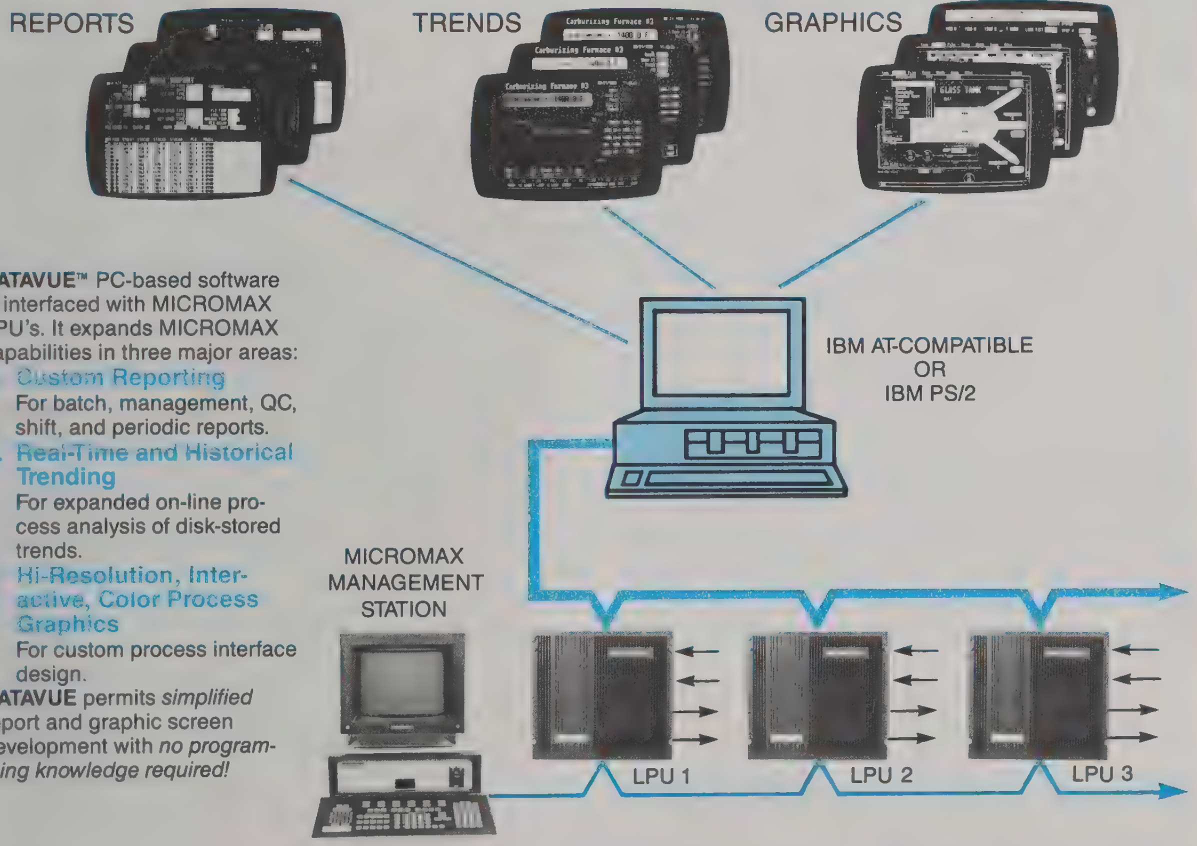
DATAVUE™ Software for MICROMAX® Process Management Systems



DATAVUE™ PC-based software is interfaced with MICROMAX LPU's. It expands MICROMAX capabilities in three major areas:

1. **Custom Reporting**
   For batch, management, QC, shift, and periodic reports.
2. **Real-Time and Historical Trending**
   For expanded on-line process analysis of disk-stored trends.
3. **Hi-Resolution, Interactive, Color Process Graphics**
   For custom process interface design.

DATAVUE permits *simplified* report and graphic screen development with *no programming knowledge required!*

Major Features:

- **Supports LPU networking** Provides data access to multiple LPU's via an RS-485 network.
- **Standard PC hardware support** IBM "AT" compatible or IBM PS/2 hardware plus DOS, no special hardware/software additions.
- **Process interface redundancy** Multiple serial ports in the LPU allow PC-based DATAVUE and the Management Station to view the same data and interact with control loops.
- **Mouse-driven screen editing** For fast screen development and menu selections.
- **On-line editing/backgrounding of report/trend data** Data acquisition to disk files is independent of DOS allowing on-line screen editing without data loss.
- **Pixel-resolution process graphics** Use 16 colors for EGA or VGA graphics to pixel resolution.

Continued

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DATAVUE™ Software

Major Features Continued

- **On-line data archiving** DIF converted data files can be archived to diskette for off-line analysis using spreadsheet software such as LOTUS 1-2-3.
- **Icon library** Placement, sizing and rotating of standard icons such as valves, pumps, tanks, and bar charts simplifies screen design, or build your own and save in library.
- **Standard data/loop template formats** Formats included for PID loop plus group data bar graph and sizeable trend graph templates.
- **Flexible graphics screen animation** Bar charts for any shape, moving setpoint indicators, color changes, messages, blinking, and sound are easily created to show process changes or alert the operator.
- **Free placement of trend graphs** A trend graph can be sized to be anywhere on screen.
- **Flexible operator interface design** Create screen hierarchy and operator/screen interaction using redefinable function keys or "hot spots" and user-defined ENTER fields sensitive to mouse or cursor selection.
- **Flexible alarming** The latest two alarm messages can be placed anywhere on screens; also standard alarm summary/history screens provided.
- **On-screen floating point calculations** For screen animation or reporting of dynamic data from multiple LPUs.
- **Batch parameter loading** Screens can be created to download LPU writeable parameters such as "constant values" to change batch setpoints, tuning constants, etc.
- **Simple MICROMAX LPU Data Access** Automatic generation of database reference files and mouse selection from pop-up LPU parameter menus simplifies data selection for placement on screen.
- **Graphic printout** Print any graphic screen with colors represented in shades of gray.
- **Power fail recovery** Data collection continues for trends and reports after power loss.
- **On-line labelling screens** For parameter tags, descriptors, and on-off labels.
- **Security** Password protection for editing function, create your own for parameter entry.

General Description

DATAVUE is a comprehensive PC-based software package that complements the reporting, trending, and alarming capabilities of the MICROMAX Process Management System. It also expands the operator interface to the realm of high-resolution, interactive process graphics. Mouse-driven screen development utilizing pull-down menus and windowed MICROMAX parameter lists allow you to design screens quickly without any programming knowledge. A DATAVUE software package is available in two versions: Reports/Trends offering no graphics drawing capability, or Reports/Trends/Graphics offering all of the package features.

The versatility of DATAVUE's software can range from pure data acquisition and process analysis utilizing custom report formats and trends to complete supervision of processes through high resolution process graphic displays and menu lists. Its high-speed link to multiple MICROMAX LPU's using a standard PC serial communications port offers real-time access to process data for monitoring only, or for interactive control of process loops and parameter changes from any screen. Since DATAVUE normally accesses data from the optional LPU communication port it can be assigned a task totally independent of the MICROMAX Management Station or offer process interface redundancy.

Data collection for reports and trends is run as a background task independent of DOS. This allows screens to be developed or edited concurrently without loss of important process data. Data stored to a disk file can be converted on-line to a DIF format, then archived to a floppy disk allowing the data to be analyzed off-line using spreadsheet software.

DATAVUE also lets you get on-line quickly. For data acquisition, predawn templates of data bar graph and trend formats are provided, alterable if desired. Report formats or tabular

General Description Continued

data screens are generated in a freeform manner. In addition, database references for LPU data are automatically generated while other local database files can be simply developed if necessary. Advanced graphic drawing features and simplified animation tools speed custom graphics development for mimicking of process operations. Features such as Function-key definition by menu selection and free placement of "hot spots" for screen areas responsive to a mouse or cursor selection also allow fast creation of hierarchical menus and operator prompts to simplify the operator interface.

Control interaction with the process is easily developed on any screen for changing setpoints, assuming manual control, starting or stopping setpoint programs, forcing an I/O status, or entering related process parameter changes. To further speed the control interface development, a standard control loop detail screen with an integral trend plot and a faceplate template applicable to any loop are provided.

As a result of its versatility and extensive capability, DATAVUE software enables you to define how MICROMAX data is to be reported, displayed, and interacted upon to increase the efficiency of your process operations.

Custom Reporting

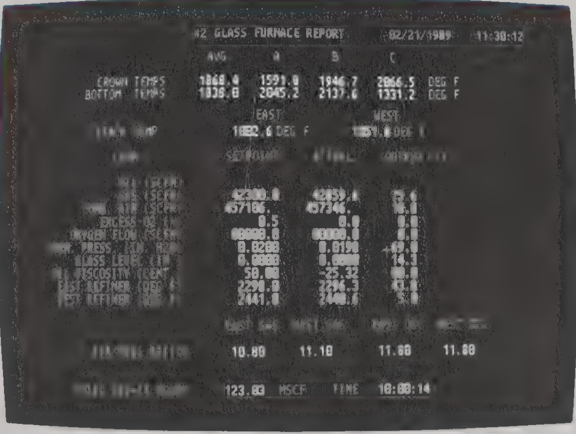
Reporting Features:

- **Up to 50 concurrent reports.**
- **Freeform entry of text and data on screen.**
- **Assignable field width optimizes parameter resolution.**
- **Simple LPU data placement from menus.**
- **Full 8½" x 11" thru 11" x 13½" formats.**
- **Optional appended batch log report, up to 24 parameters wide and 9999 sample lines.**
- **Operator on-line data/text ENTER fields assignable with field length.**
- **On-screen calculations updated on logging or report completion or combined with LPU calculations.**
- **Start/stop and print/store to disk on day/time, interval, alarm, or event.**
- **Report data convertible to spreadsheet compatible format (DIF format).**
- **On-line review of historical reports with comment/text entry.**
- **Automatic generation of disk files for repetitive cycles (up to 26).**

DATAVUE's freeform reporting allows you to design your own formats for screen presentation and normal (80 column) or wide-carriage printouts. "Grid snapping" automatically aligns text strings and data fields as necessary for proper spacing. Page Up and Down keys or cursor/mouse-directed "sliders" allow access to report areas off screen when necessary. MICROMAX data values such as analog inputs, pseudo-point calculations, timer/counter values, constants, etc. or discrete on/off status labels may be positioned anywhere on the report for dynamic updating (Fig. 1). Calculations such as averages, deviations, etc., may be performed on screen data while the report screen is viewed or at the time the report data is periodically logged or full report completed.

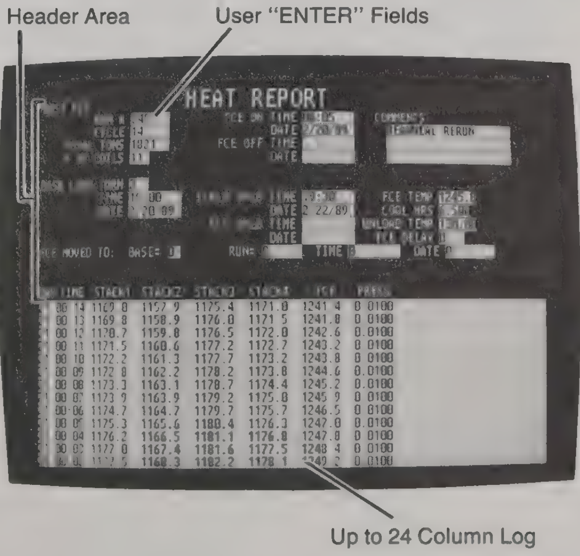
For batch reporting or periodic logging, up to 24 parameters may be logged to disk at specified intervals ranging from seconds to hours. These values appear as

(Continued)



```
#2 GLASS FURNACE REPORT     02/21/1989   11:30:12
                  AVG      A        B        C
  CROWN TEMPS   1868.4   1591.0   1946.7   2066.5  DEG F
 BOTTOM TEMPS   1838.8   2045.2   2137.6   1331.2  DEG F
                    EAST              WEST
                  1882.6 DEG F

                  10.80    11.10      11.08    11.08

                  123.03  MSCF    TIME   10:00:14
```

Fig. 1. Management-Type Report.



```
HEAT REPORT
        FCE ON TIME            COMMENTS
               DATE 2/20/89     TECHNICAL RERUN
  CYCLE 14  FCE OFF TIME
   TONS 1821           DATE
                                     FCE TEMP 1245.0
                       DATE 2 22/89  COOL HRS
                       TIME        UNLOAD TEMP
                       DATE          FCE DELAY
FCE MOVED TO:  BASE=       RUN=       TIME        DATE

     TIME  STACK1  STACK2  STACK3  STACK4   FCE    PRESS
    00 14  1169.0  1157.9  1175.4  1171.0  1241.4  0.0100
    00 13  1169.8  1158.9  1176.0  1171.5  1241.8  0.0100
    00 12  1170.7  1159.8  1176.5  1172.0  1242.6  0.0100
    00 11  1171.5  1160.6  1177.2  1172.7  1243.2  0.0100
    00 10  1172.2  1161.3  1177.7  1173.2  1243.8  0.0100
    00 09  1172.8  1162.2  1178.2  1173.8  1244.6  0.0100
    00 08  1173.3  1163.1  1178.7  1174.4  1245.2  0.0100
    00 07  1173.9  1163.9  1179.2  1175.0  1245.9  0.0100
    00 06  1174.7  1164.7  1179.7  1175.7  1246.5  0.0100
    00 05  1175.3  1165.6  1180.4  1176.3  1247.0  0.0100
    00 04  1176.2  1166.5  1181.1  1176.8  1247.8  0.0100
    00 03  1177.0  1167.4  1181.6  1177.5  1248.4  0.0100
                   1168.3  1182.2  1178.1          0.0100
```

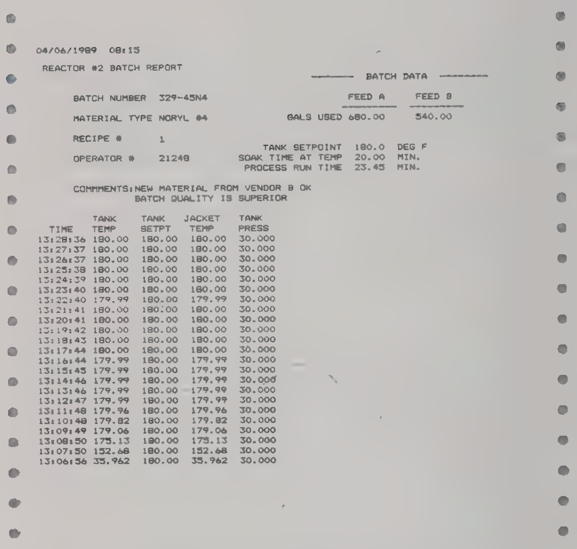
Fig. 2. Batch-Type Report.

Custom Reporting Continued

line data appended to a custom report header which may contain other information relative to the batch (Fig. 2). "ENTER" fields may be designated for operator screen entry of batch data (material type, load number, weights, etc.), operator comments, setpoint, recipe values, lab data, etc. which may be added to running or historical reports. The batch logging format is typical of reporting requirements for annealing ovens, batch reactors, batch furnaces, QC logs, or shift reports.

The operator may schedule a report to run (data starts to be logged to a disk file) or be stopped based on day of week and time or on event (CR, DI, DO status change). Alternatively, a report may be started or stopped from any screen. Reports may be printed on completion (Fig. 3) and/or stored to disk for later screen recall, review, comment additions, and printout. Periodic logs, typical of shift reports, may be printed with a history log of data over the time interval.

Reports may be archived on-line to floppy disk or restored to disk from floppy disk for review on-screen. On-line DIF file conversion of report data is selectable prior to archiving.



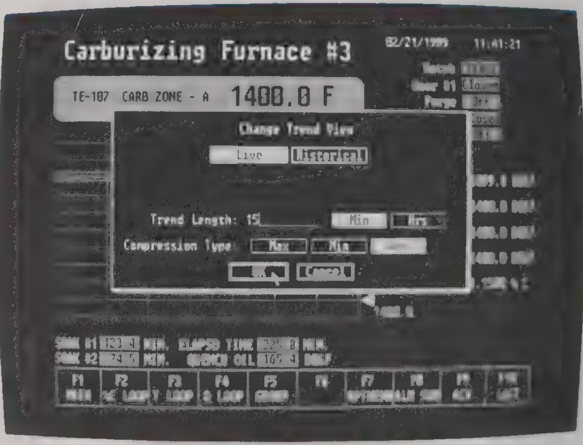
```
04/06/1989  08:15
 REACTOR #2 BATCH REPORT
                                                  -------  BATCH DATA  --------

     BATCH NUMBER  329-45N4                                 FEED A     FEED B
                                                           --------   --------
     MATERIAL TYPE NORYL #4                       GALS USED 680.00     540.00

     RECIPE #        1
                                             TANK SETPOINT  180.0   DEG F
     OPERATOR #    21248               SOAK TIME AT TEMP  20.00   MIN.
                                        PROCESS RUN TIME  23.45   MIN.

     COMMMENTS:NEW MATERIAL FROM VENDOR B OK
               BATCH QUALITY IS SUPERIOR

           TANK     TANK    JACKET    TANK
  TIME     TEMP     SETPT    TEMP     PRESS
13:28:36 180.00   180.00   180.00   30.000
13:27:37 180.00   180.00   180.00   30.000
13:26:37 180.00   180.00   180.00   30.000
13:25:38 180.00   180.00   180.00   30.000
13:24:39 180.00   180.00   180.00   30.000
13:23:40 180.00   180.00   180.00   30.000
13:22:40 179.99   180.00   179.99   30.000
13:21:41 180.00   180.00   180.00   30.000
13:20:41 180.00   180.00   180.00   30.000
13:19:42 180.00   180.00   180.00   30.000
13:18:43 180.00   180.00   180.00   30.000
13:17:44 180.00   180.00   180.00   30.000
13:16:44 179.99   180.00   179.99   30.000
13:15:45 179.99   180.00   179.99   30.000
13:14:46 179.99   180.00   179.99   30.000
13:13:46 179.99   180.00   179.99   30.000
13:12:47 179.99   180.00   179.99   30.000
13:11:48 179.96   180.00   179.96   30.000
13:10:48 179.82   180.00   179.82   30.000
13:09:49 179.06   180.00   179.06   30.000
13:08:50 175.13   180.00   175.13   30.000
13:07:50 152.68   180.00   152.68   30.000
13:06:56 35.962   180.00   35.962   30.000
```

Fig. 3. Batch Report Printout.

Trending

Trending Features:

- **Up to 50 concurrent trend screens.**
- **Sample rates of 2 to 999999 seconds.**
- **Color selection for each trend plot.**
- **Horizontal or vertical trend formats; up to 12 parameters.**
- **Special horizontal template format with rotating trend parameter window and indicators of alarm setpoints.**
- **Trend graphs sizeable to fit on any tabular or graphic display.**
- **Trend data stored to disk.**
- **Trend data files convertible on-line to DIF format, spreadsheet compatible.**
- **On-line selection of trend time window.**
- **On-line selectable data compression on trend plotting; real-time or historical trend data for a selected time window plotted as averaged data or highest/lowest values of data samples obtained.**
- **Trend dots automatically connected for small time windows.**
- **Trend start/stop on time or event or by function key/hot spot access to trend menus.**
- **Trend lines turn to red on alarm.**



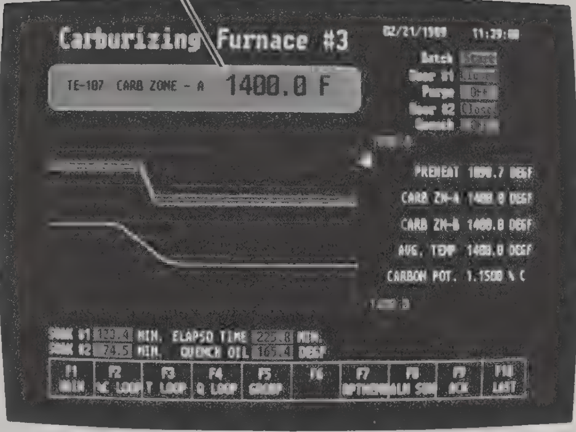
Trend Length: 15

Fig. 4. Trend view feature for changing time window and historical recall.

DATAVUE provides both real-time and historical trending for analyzing process changes over time. The operator may select a new time-window on-line using the "trend view" feature for narrowing or expanding the trend view (Fig. 4). Depending on time window span and sample rate, selectable data compression can improve analysis of process changes by plotting the average of data samples between plotted points, or the highest/lowest values. In this way, the maximum process excursions can be viewed on expanded trend views. This data compression can also be selected on-line for historical trend review. The operator may select a historical trend file on-line based on date and time and the desired time window such as 30 minutes, 1 hour, 8 hours, etc. Then the time window can be changed to obtain a longer or shorter term view of the process changes.

Trend graphs are easily configured using a standard trend template with a rotating data window (Fig. 5) which emulates MICROMAX trend screen features or a basic vertical or horizontal trend graph with only range windows. Trend plots can be easily sized in both directions to fit any part of a screen such as a tabular data screen or a loop or graphic screen. Point data is menu-selected along with trend color. The range of each data point trended (which may be different) is presented in the range windows at the top and bottom of the scale.

Trend data, running or historical, can be archived on-line to floppy disk in a normal format or a DIF format for off-line spreadsheet analysis. Trend files can also be restored to hard disk from floppy for historical review. Trend graphs can be started or stopped on event coincident with a batch or time and printed on demand.


Rotating data window

Carburizing Furnace #3
02/21/1988 11:29:00
TE-107 CARB ZONE - A 1400.0 F
Batch
Purge
Door #2 Closed
PREHEAT 1800.7 DEGF
CARB ZN-A 1400.0 DEGF
CARB ZN-B 1400.0 DEGF
AVG. TEMP 1400.0 DEGF
CARBON POT. 1.1500 % C
SOAK #1 123.4 MIN. ELAPSD TIME 225.8 MIN.
SOAK #2 74.5 MIN. QUENCH OIL 165.4 DEGF
F1
F2
F3 T LOOP
F4 Q LOOP
F5 GROUP
F6
F7
F8
F9 ACK
F10 LAST

Fig. 5. Horizontal Trend.

Process Graphics

Graphics Features

- **Hi-resolution, vector-based graphics (pixel resolution).**
- **Choice of 16 colors: interior of shape, exterior (text or shape borders).**
- **Choice of 37 "fill" patterns for interiors of shapes.**
- **Freeform placement of text, MICROMAX data, and shapes.**
- **Drawing of text (4 sizes), circles, ellipses, rectangles, lines (6 styles/selectable width), arrows, polygons, with border colors/widths.**
- **Use icon library or build your own, resize on screen or change attributes.**
- **Assignable "Hot Spots" to screen areas permit mouse/cursor operator interface for changing screens, menu selections, writing values, start/stop, changing I/O status, etc.**
- **Assignable function keys for operator interface development.**
- **Assignable "ENTER" fields anywhere on the screen, cursor/mouse selected, for text or parameter writes to LPUs.**
- **Grid snapping for ease of text and shape placement.**
- **Copy, move, size operations.**
- **Animation via color conditionals on analog I/O (7 levels) or discrete I/O status (2 levels), indicators (SP, alarms), blinking, sound (siren or beep), moving bar charts.**
- **IF-THEN-ELSE and math statements for special entry requirements and complex animation.**

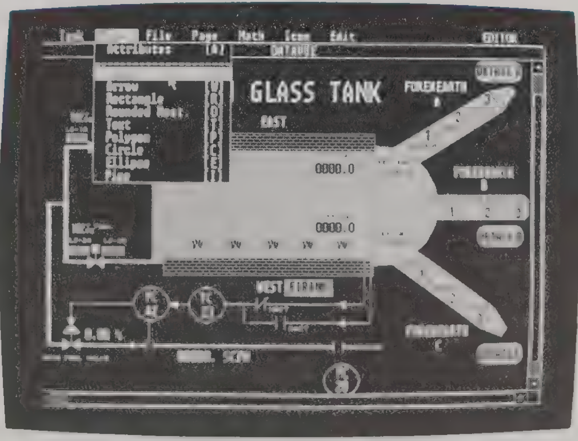

File
Page
Math
Icon
Edit
EDITOR
Attributes
DATAVUE
Rectangle
Text
Polygon
Circle
Ellipse
GLASS TANK
FOREHEARTH
EAST
0000.0
0000.0

Fig. 6. Building a graphic screen.

Mouse-driven screen development, pull-down menus, windowed "dialog boxes", and advanced drawing tools available in DATAVUE speed the design of graphic screens (Fig. 6). Editing is enhanced with CAD-like features including moving and freely sizing of mouse-created shapes or standard icons such as valves or pumps obtained from a library. Any shape or combination of shapes along with their animation function, or even text, can be called an icon and stored in a library for recall and placement on any screen to simplify development. Icons can also be rotated in 90° increments for changes in direction. Similar shapes can be snapped to grid pattern along with text and data for precise positioning.

(Continued)

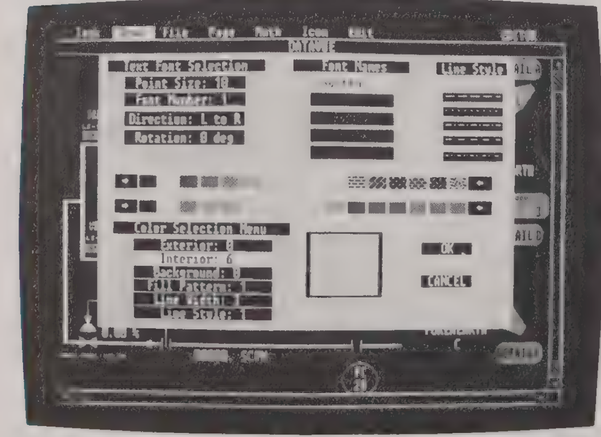
Process Graphics Continued

An Attributes window (Fig. 7) can be selected at any time to choose (or change existing) exterior and interior color, background color to identify operator entry fields, line width and style, text size and direction, or a "fill" pattern for shape interiors. Editing of actions applied to shapes or attribute changes are executed simply by selecting the editing function from a pull-down menu and pointing to the shape or function to be edited (Fig. 8). Sliders activated with a mouse or cursor are used to go off screen for creating or viewing expanded process area screens.

For process monitoring, a trend graph can be easily placed anywhere on the graphic screen (Fig. 9). Loop parameters such as process variable, setpoint and output could be viewed over a selected time span for process upset evaluation or loop tuning. A loop template icon placeable anywhere on the screen and assignable to any loop plus a preformatted loop detail screen (Fig. 10) are provided to simplify the control loop interface configuration.

Screen animation capability is extensive, and easy to configure. For example, any shape (such as a tank) may function as a bar graph with the level changing in a selected color and fill pattern based on a parameter value. The same tank interior color can be changed up to 7 different colors as the tank temperature changes. For normal bar graphs, indicators may be simply ranged and placed next to bars for setpoint indication or alarm levels. Color changes, including blinking, may be applied to any "pipe" or shape to show material flow or I/O status change. IF-THEN-ELSE statements which can combine simple math, logic, and compare functions are used for more extensive animation and multiple actions such as writing of parameter values for a recipe based on a recipe name or number; placing messages anywhere on the screen; moving, placing, or blanking graphic shapes, etc.

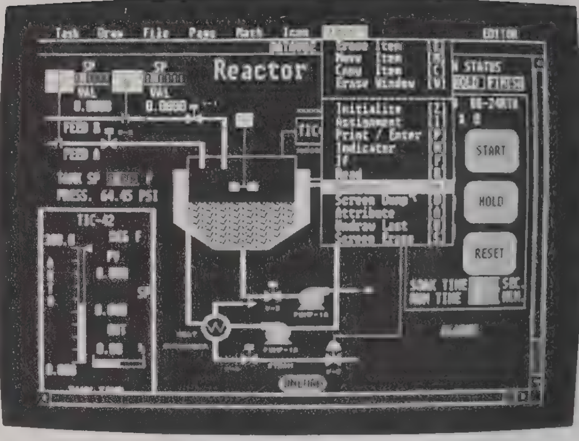
On-screen calculations can be ultilized for calculating dynamic deviations, averages, or totals from one or more LPU's, represented as bar graphs on the screen, or simply displayed in numeric format with the desired field width.


File
Math
Icon
Text Font Selection
Font Names
Line Style
Color Selection Menu
OK
CANCEL

Point Size: 10
Font Number: 1
Direction: L to R
Rotation: 0 deg

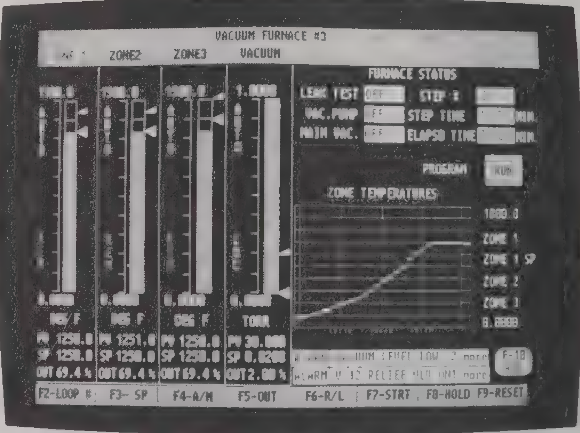
Exterior: 0
Interior: 6
Background: 0
Fill Pattern: 1
Line Width: 1
Line Style: 1

Fig. 7. Attributes window.


Task
Draw
File
Page
Math
Icon
EDITOR
Reactor
Erase Item
Move Item
Copy Item
Erase Window
Initialize
Assignment
Print / Enter
Indicator
If
Screen Dump
Attribute
Undraw Last
Screen Erase
STATUS
SP
VAL
FEED B
FEED A
TIC
TIC-42
DEG F
PV
OUT
START
HOLD
RESET
SOAK TIME
RUN TIME
SEC.
MIN.

PRESS. 64.65 PSI

Fig. 8. Editing a graphic screen.


VACUUM FURNACE #3
ZONE2
ZONE3
VACUUM
FURNACE STATUS
LEAK TEST
VAC.PUMP
MAIN VAC.
STEP #
STEP TIME
ELAPSD TIME
MIN.
MIN.
PROGRAM
RUN
ZONE TEMPERATURES
1000.0
ZONE 1
ZONE 1 SP
ZONE 2
ZONE 3
0.0000
1.0000
DEG F
DEG F
DEG F
TORR
F-10
F2-LOOP #
F3- SP
F4-A/M
F5-OUT
F6-R/L
F7-STRT
F8-HOLD
F9-RESET

LEAK TEST OFF

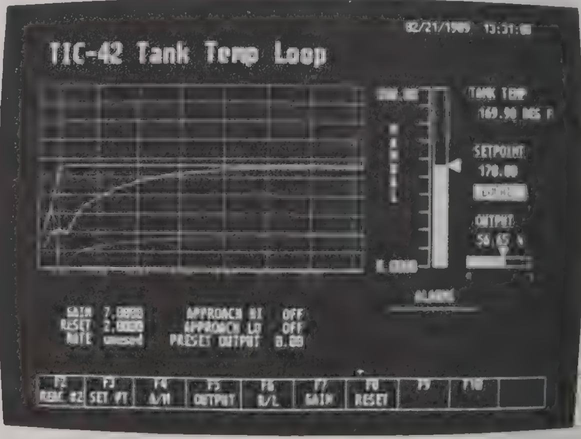
PV 1250.0
SP 1250.0
OUT 69.4 %

PV 1251.0
SP 1250.0
OUT 69.4 %

PV 1250.0
SP 1250.0
OUT 69.4 %

PV 30.000
SP 0.0200
OUT 2.00 %

Fig. 9. Vacuum furnace control screen with trending.


TIC-42 Tank Temp Loop
0.0000
ALARMS
F2
F3
SET PT
F4
A/M
F5
OUTPUT
F6
R/L
F7
GAIN
F8
RESET
F9
F10

02/21/1989 13:31:00

TANK TEMP
169.90 DEG F

SETPOINT
170.00

OUTPUT
56.65 %

GAIN 7.0000
RESET 2.0000
RATE unused

APPROACH HI OFF
APPROACH LO OFF
PRESET OUTPUT 0.00

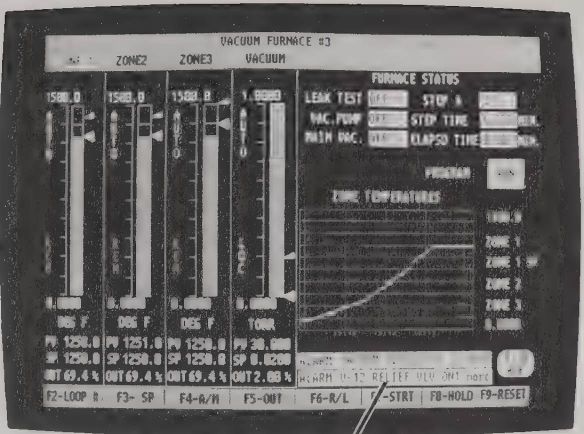
Fig. 10. Fixed template for a control loop detail screen.

Alarming

Alarms are created independent of the Management Station, applicable to any analog value or discrete I/O state. If an alarm occurs, a "target screen" can be defined for each alarm to change the display when acknowledged to one that is more critical to the alarm state. An alarm icon may be created and applied to any screen (Fig. 11) which can blink to identify any new alarms and display an alarm message. The latest 2 active alarms with their messages can be displayed with the number of unacknowledged alarms also indicated. An alarm summary screen shows active alarms with the alarm message plus time and date of occurrence while an alarm history screen shows the date/time of alarm in/out.

Alarming Features:

- **Definable alarm icon applied to any screen.**
- **Assignable function key for Acknowledge.**
- **Preformatted alarm summary/history screens.**
- **Assignable "target" screens on Acknowledge.**


VACUUM FURNACE #3
ZONE2
ZONE3
VACUUM
FURNACE STATUS
LEAK TEST
VAC.PUMP
MAIN VAC.
STEP #
STEP TIME
ELAPSD TIME
PROGRAM
ZONE TEMPERATURES
DEG F
TORR
F2-LOOP #
F3- SP
F4-A/M
F5-OUT
F6-R/L
F7-STRT
F8-HOLD
F9-RESET

User Configured Alarm "Icon"

Fig. 11. Alarm messages may be added to any graphic screen.

Operator Interface Development

Function keys F1 through F10 can have different or common assignments on each screen (Fig. 12) This allows you to customize the operator interface including screen heirarchy and interactive functions. For expanded requirements, an additional 20 function keys can be defined by using the Shift and Control keys. Key assignments for screen access include selection of specific screens, menu screens, windowed menu lists of pending, running, and historical reports or trends, or last screen. This enables an efficient screen heirarchy to be developed for your operators and supervisory personnel. Screens can also be called up automatically on event.

For supervisory control, the F-keys can be configured to bring up operator message prompts for selecting a loop and entering control setpoints, output levels, tuning constant values, or for entering individual batch parameters or a recipe with predefined parameters from the database (Fig. 13). The key prompt execution can also be configured to ask for a security code prior to entry. Batches can be started or stopped, setpoint programs put in hold or reset, loops put in auto/manual or remote/local sepoint mode, pumps or solenoid valves turned off/on, alarms acknowledged, etc. by configuring F-key operations accordingly.

(Continued)

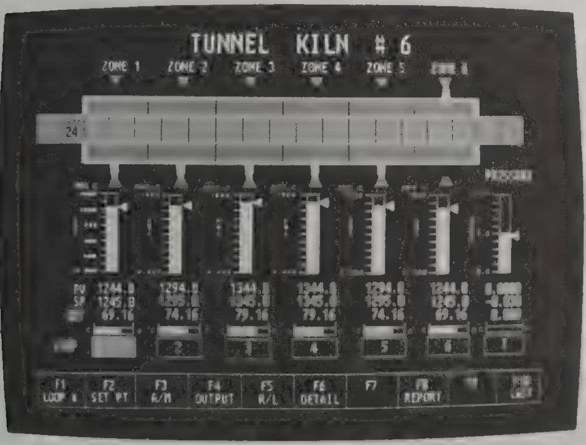
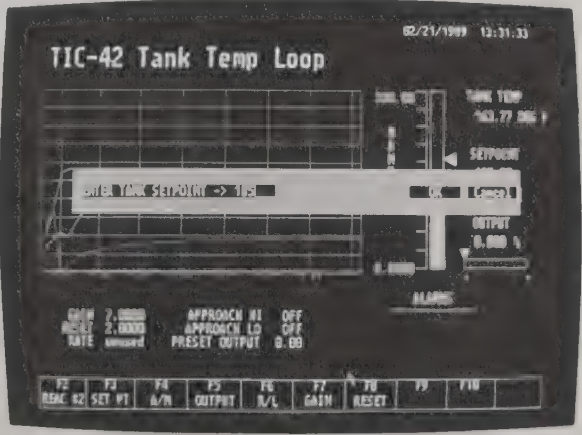

TUNNEL KILN # 6
ZONE 1
ZONE 2
ZONE 3
ZONE 4
ZONE 5
F1 LOOP #
F2 SET PT
F3 A/M
F4 OUTPUT
F5 R/L
F6 DETAIL
F7
F8 REPORT

Fig. 12. Operator interface with definable function keys.


TIC-42 Tank Temp Loop
TANK TEMP
SETPOINT
OUTPUT
ALARMS
F2 REAC #2
F3 SET PT
F4 A/M
F5 OUTPUT
F6 R/L
F7 GAIN
F8 RESET
F9
F10

ENTER TANK SETPOINT -> 185

GAIN 2.0000
RESET 2.0000
RATE unused
APPROACH HI OFF
APPROACH LO OFF
PRESET OUTPUT 0.00

Fig. 13. Key prompts are easily defined for operator entry of setpoints, recipes, etc.

Operator Interface Development Continued

Hot spots are defined to be any portion of a screen (around a "button" or shape, for example) that is responsive to cursor or mouse "clicking" to cause actions the same as those defined for function keys (Fig. 14). For example, you can "click on" a Start "button" directly to start a process or position the cursor on a pump to force it on or off. The mouse or cursor may also be used to "click on" ENTER fields placed anywhere on the screen where a numeric entry can be made to write a value to the LPU.

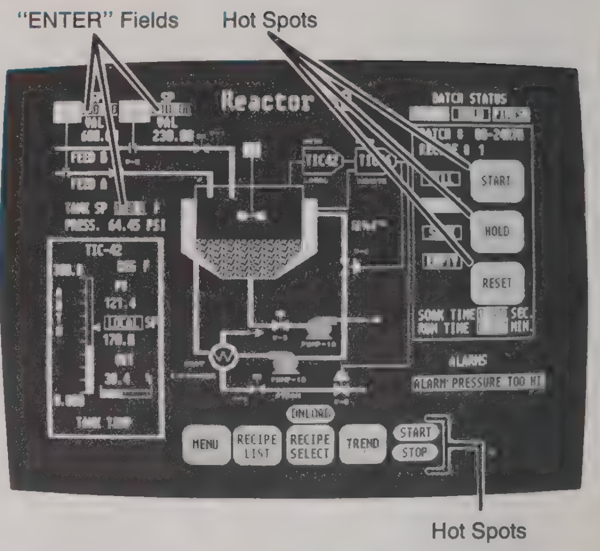


Fig. 14. Operator interface showing Hot Spots and ENTER fields.

Specifications

Package options: Reports/Trends only (no graphics drawing except rectangles) or Reports/Trends/Graphics.

MICROMAX Data Access: Essentially all MICROMAX data is accessible for read to the screens. Available write parameters: Discrete I/O (force); loop local/remote setpoints, A/M, R/L, output, tuning constants, setpoint programmer start, hold, advance, reset; constant values.

Data communications: 300 – 19.2K Baud, asynchronous, RS-422/485

No. of LPU's addressable on network: 32

Max. distance: 2500 ft. (assumes use of recommended Belden 8728 cable or equivalent, routing in conduit or in low power cable tray, and recommended interface hardware).

No. of graphic screens: Disk-limited (5-15K bytes/screen type)

No. of parameters/screen: 75

Screen update rate: selectable, 2 seconds, typical

Hardware: IBM PS/2 Model 30 286, Model 50 and above, "AT" Computers, Compaq Deskpro 286, or 386S (386S recommended for graphics applications); with the following requirements:

- 1 MB RAM memory.
- 20 MB hard disk min., more for extensive historical data.
- 1 or more floppy drives (3½", 1.44 MB or 5¼", 1.2 MB HD).
- EGA or VGA graphics board.
- RS-422 direct (not on PS/2 Series) or RS-232 serial port. (RS-232 serial port requires RS-422/232 converter).
- EGA (640x350 pixels) or VGA (640x480 pixels) monitor.

(Note: L&N guarantees performance on these computers only.)

Operating System: DOS 2.0 and above (computer dependent).

Mouse (serial board required if not direct input).

Options:

Epson FX wide carriage printers, IBM Proprinter. Graphics printout requires additional 3 MB RAM Memory.

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For a detailed description of MICROMAX Process Management Systems, see L&N Publication GO.0001-DB

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A UNIT OF GENERAL SIGNAL

Instrument and System Solutions!

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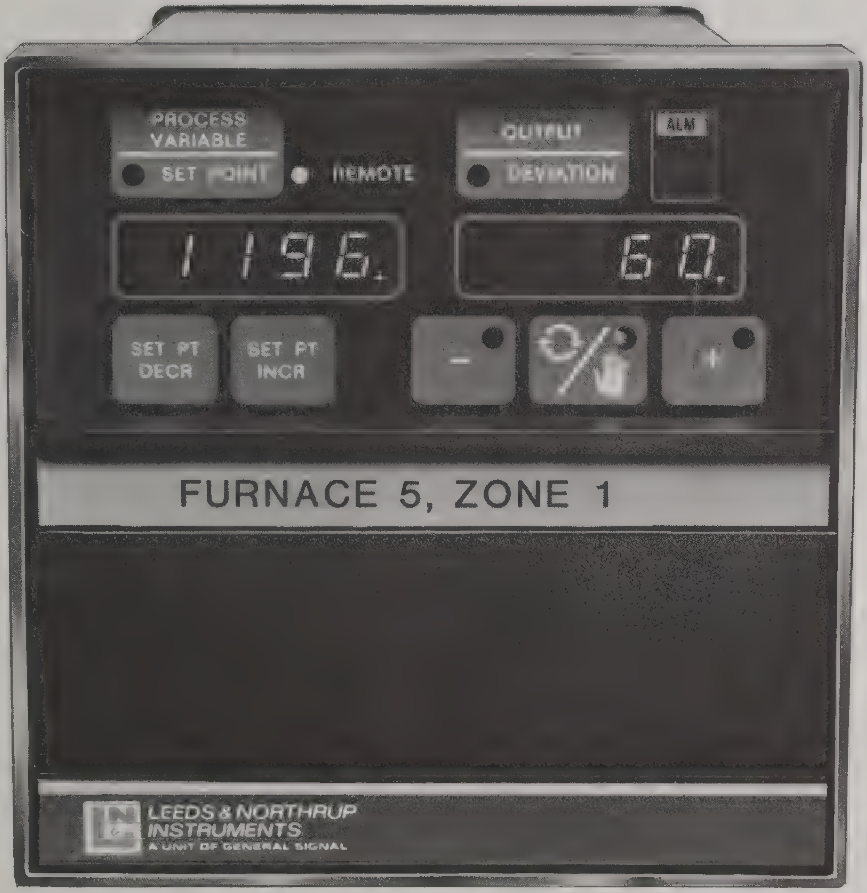
Electromax® V PLUS

General-Purpose Single-Loop Controller


PROCESS VARIABLE
SET POINT
REMOTE
OUTPUT
DEVIATION
ALM
1196.
60.
SET PT DECR
SET PT INCR
–
+
FURNACE 5, ZONE 1
LEEDS & NORTHRUP INSTRUMENTS
A UNIT OF GENERAL SIGNAL

- Exceptional stability, accuracy, reproducibility and reliability for industrial and process control
- State-of-the-art microprocessor techniques
- Resolution to 1 degree F or C. or 1 count
- Dual-input feature available for ratio, summer, set-point bias, feedforward or mass-flow applications
- Digital setting of tuning, alarm and calibration values
- Optional self-tuning of proportional, reset and rate
- Full choice of proportioning-control outputs: Current-Adjusting Type, Duration-Adjusting Type or Position-Adjusting Type (On-Off Control and Limit Alarming available)
- Standard proportioning-controller features include auto/manual operation, dual alarms and remote/local set-point operation
- All popular controller options provided as standard, for maximum versatility and adaptability
- Serial communications

LEEDS & NORTHRUP
A UNIT OF GENERAL SIGNAL

Instrument and System Solutions!

L&N's Electromax V^{PLUS} General-Purpose Controller now brings all the advantages of state-of-the-art microprocessor techniques to both industrial and process control applications (temperature, flow, mass flow, ratio, level, pressure, pH, etc.).

Accepting direct milivoltage, thermocouple, Rayotube® detector or RTD (low-level) inputs or transmitter (high-level) inputs, Electromax V^{PLUS} presents bold LED digital display—clearly readable from a distance—of process variable (or set point) and deviation (or control output). Thermocouple, Rayotube or RTD inputs (either low- or high-level) are linearized for direct-reading in degrees F or C. Set points, alarm settings and all essential controller parameters are quickly and easily established (using the same digital displays) with touch-switches at the front panel—can be recalled for readout at any time, without affecting controller operation.

There is no "fiddling" with dials, no screwdriver pot adjustments, no "guesstimates"—values are entered, and control exercised, with the precise resolution possible only with digital settings. And even if line power is lost, these values are retained in the non-volatile memory in the controller, assuring prompt return to normal control operation after an upset.

Communication with a host computer or other intelligent device is available for data retrieval, supervisory control or DDC backup through an RS422/485 Serial Interface. The communications protocol provides multidrop binary asynchronous data transmission over a five-wire shielded cable for distances up to 1000 feet.

FRONT PANEL

The Electromax V^{PLUS} front panel comprises a dust-tight monoplanar sheet, with two windows for four-place, seven-segment LED alphanumeric displays, labeled touch-switches (membrane switches) for initiating various operating, programming and calibrating functions, additional LED lights for status or identification, and a printed index to the programming functions. (Programming, calibration and remote/local touch-switch operation may be inhibited either by jumper-selection on the CPU board or on command by a digital input signal from a remote source.)

During normal control operation, a drop-down hinged door conceals the programming touch-switches and the index list. The index list is also reproduced on the back of this door, to permit notations of selected programming values as a "hard copy" reference.

INPUT SIGNAL

Input from the sensor or transmitter is connected to terminals at the rear of the case. The basic controller can accept either low-level or high-level inputs (determined by a jumper on the analog printed-circuit card). Two additional high-level inputs are available for remote set-point, feedforward, bias or other selected control functions.

Low-level inputs require an interchangeable plug-in module on the analog card; a single appropriate module covers the full working range of a standard thermocouple (B, E, J, K, N, R, S, T, Nickel-Nickel, 18% Moly or W5RE-W26RE), or a 25-ohm platinum or 100-ohm platinum or copper RTD; and modules can provide the eight most popular ranges for direct Rayotube inputs. Modules are also available for 0-10, 0-20, 0-100, or −5 to +5 mV inputs. The thermocouple, Rayotube and RTD ranges include linearization, so that LED displays are direct-reading in F or C (software-selectable). Upscale or downscale thermocouple failsafe is jumper-selected. Isolation of the low-level input is available to eliminate ground loops or problems associated with high RFI/EMI environments.

No module is required for a high-level input; range is 0-4 or 1-5 V (software-selectable) or—with a shunt resistor—0-16 or 4-20 mA. For these high-level inputs, or the low-level millivolt inputs, the controller can be scaled (by the front-panel touch-switches) so the LED display reads directly in engineering units, corresponding to the linear range. Maximum span is 5000 units, over the range of −9999 to +9999, with an appropriate decimal point; for example, −0.15 to 0 to +0.15, 0-14, 50-150, or 1000-5000.

High-level thermocouple or RTD transmitter inputs can be linearized for direct-reading in F or C over the span of the transmitter or 10% of the low-level RTD or thermocouple range, whichever is greater.

SET POINT

The left-hand window displays either the Process-Variable or Set-Point value directly in engineering units, selected by pressing the labelled touch-switch above it; an LED adjacent to the legend identifies the display. The Set-Point value (initially established during the programming mode) can be decreased or increased by pressing the touch-switches ("SET PT DECR", "SET PT INCR") below the window.

An optional 4-20 mA auxiliary output, proportional to the process variable (linearized), set point or deviation, can be selected for remote recording, data processing, etc. It can also be used with the Set-Point Programming option to provide a remote set point to other controllers.

AUTO/MANUAL STATION

The right-hand window displays either the Output value (in percent) or the Deviation value (in process-variable units), selected by pressing the touch-switch above it; an LED adjacent to the legend similarly identifies the selected display.

Three touch-switches below the window provide bumpless transfer from automatic to manual control (and vice versa) and manual operation. The center switch is pressed to select the mode; an LED indicates manual operation. In the manual mode, the Output value will be displayed in the window, and the "−" and "+" switches can be pressed to decrease or increase the control output directly. In the automatic mode, either the Deviation or the Output value can be displayed in the window; in Position-Adjusting Type controllers, an LED behind each switch indicates whether the "decrease" or "increase" triac is being energized (direction of change).

As an option, an input port can be provided at the rear of the case to accept digital signals for remote auto/manual switching and manual operation (see "Remote Operation").

CONTROL OUTPUT

The Electromax V^{PLUS} Proportioning Controller is available with a choice of control outputs. Operations described assume reverse-acting control; either reverse-acting or direct-acting operation is software-selectable. The numeric Output Display on the front panel is also reversible to match the status of the final control element, useful in representing the "% open" or "% closed" of a control valve. Reversal of the display also reverses the

Touch-switch selector for Process-Variable or Set-Point display (LED illuminated for Set Point)

Light-Emitting Diode (LED) is illuminated whenever Remote Set Point is operative

Touch-switch selector for Output or Deviation display (LED illuminated for Deviation)

Alarm legends, illuminated when alarms exceed programmed high or low settings

Numeric display of Process-Variable or Set-Point value; alphanumeric display of Program-function (e.g., "F 1") or Calibrate-function (e.g., "C 1") identification

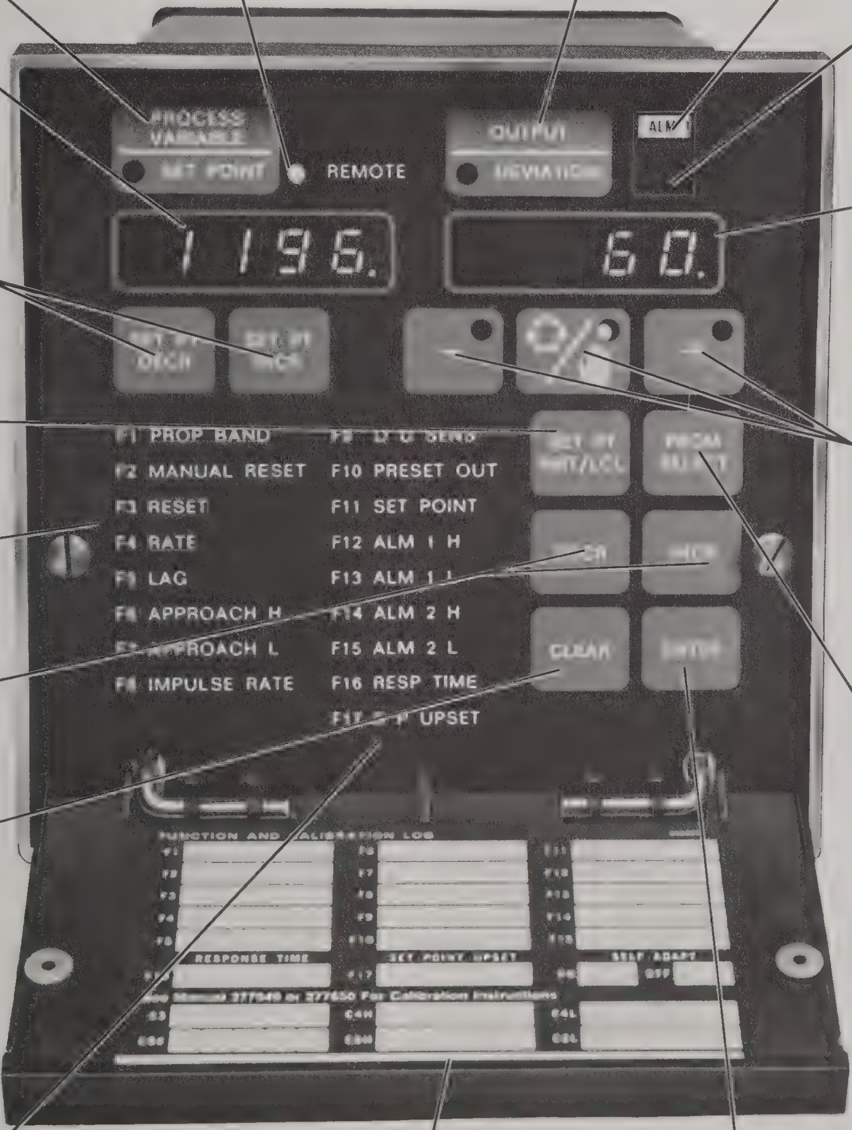
Touch-switches change value of Set Point (when displayed above) at a logarithmic rate to facilitate large or small changes

Touch-switch transfers controller from local to (optional) Remote Set Point

Index on panel identifies "F" functions sequentially displayed in Program mode

Touch-switches decrease or increase the numerical value of the "F" or "C" function selected

Touch-switch (1) returns controller from Program or Calibrate mode to the operating mode, *after* an entry, or (2) clears an *unentered* value from the display and recalls the existing value (still in memory); pressing again returns the controller to the operating mode


PROCESS VARIABLE
SET POINT
REMOTE
OUTPUT
DEVIATION
ALM 1
1196.
60.
SET PT DECR
SET PT INCR
%
SET PT RMT/LCL
DECR
INCR
CLEAR
ENTER
F1 PROP BAND
F2 MANUAL RESET
F3 RESET
F4 RATE
F5 LAG
F6 APPROACH H
F7 APPROACH L
F8 IMPULSE RATE
F10 PRESET OUT
F11 SET POINT
F12 ALM 1 H
F13 ALM 1 L
F14 ALM 2 H
F15 ALM 2 L
F16 RESP TIME
F17 S P UPSET
FUNCTION AND CALIBRATION LOG
RESPONSE TIME
SET POINT UPSET
SELF ADAPT

OUTPUT legend, illuminated when output relay or triac of Duration-Adjusting Type controller is energized

Numeric display of Output or Deviation value in Operate mode or parameter values in Program or Calibrate mode

Three touch-switches comprise auto/manual station. Center touch-switch selects automatic or manual control; LED is illuminated on manual. "−" and "+" touch-switches decrease or increase control outpu on manual; on Position Adjusting Type automatic control, LEDs indicate if either the "decrease" or "increase" output triac is energized

Touch-switch initiates sequential displays of program-function identifications and values in "windows" (e.g., "F 1" and "10.0") automatically cycling through the list until released. Touch-switc is also used with "SET PT RMT/LCL" switches to call up a menu mod for selection of alternate displays, configuration or calibration

"Response Time" (F16 RESP TIME) and "Set Point Upset" (F17 S P UPSET) values are entered when initiating the self-tuning sequence (Self-Tuning Option only)

Function and Calibration log on back of drop-down door permits notations of selected programmed entries

Touch-switch enters displayed function value in controller memory, and calls up next function in sequence

Leeds & Northrup

operation of the manual "–" and "+" switches. For a dual-output controller—available for heat/cool or split-range applications—the Output Display operation can be selected for each output.

6011 Current-Adjusting Type: Provides a 0-5, 1-5, 0-20 or 4-20 mA d-c control signal (field-selectable) for electrical heating with silicon-controlled-rectifier "power packages", saturable-core reactors or magnetic amplifiers, or for operation of an electropneumatic converter or other compatible control device. When input is at set point, current output is constant; with input below set point, current increases; with input above set point, current decreases.

The span of the current output may be limited in the field, with the low limit adjustable from 0-50% of span and the high limit adjustable from 100 to 50% of span. Full output resolution is retained; e.g., 8-16 mA output will correspond to 0-100% controller output.

6012 Duration-Adjusting Type: Operates an isolated SPDT Form C relay (rated 5 A at 120 V, 50/60 Hz, resistive load), with "on" time to "off" time proportioned as a function of the deviation of input from set point. Impulse rate (from 1.0 to 20.0 cycles/minute, with a resolution of 0.1 cycle/minute) is programmable from the front panel. While the relay is energized, an "OUTPUT" legend above the right-hand window is illuminated.

In addition to electric heating, D.A.T. control can be applied to full-stroked drive mechanisms or solenoid valves for fuel-fired or fluid-flow applications.

6013 Duration-Adjusting Type: Same as 6012, except it operates a triac rated 100 mA to 10 A at 120 V or 240 V, 50/60 Hz.

6014 Position-Adjusting Type: Precisely regulates the position of a motor-driven valve, vane, damper or feeder device, or a pneumatically operated valve. Output is through solid-state triacs suitable for operating a 10210-Series or 10260-Series Drive Mechanism or a 10973 Motor/Pneumatic Transducer directly, or an 11360-Series Heavy-Duty Drive Unit through reversing contactors.

The 6014 energizes the "increase" and "decrease" windings of a drive-mechanism motor, for example, through the two triacs, rated 50 mA to 1 A. (The triac voltage rating—120 V, 50/60 Hz, or 240 V, 50/60 Hz—matches the line-power specification for the controller.) When controller input goes above set point, the "decrease" winding is energized and the "–" switch is illuminated. With input below set point, the "increase" winding is energized and the "+" switch is illuminated. At set point, both windings are deenergized and the switch lights are out. Inherent failsafe operation is provided since, if line power fails, the triacs will be deenergized and the drive mechanism or Motor/Pneumatic Transducer will maintain its last position.

A Drive-Unit Sensitivity adjustment (10 to 100% of output, with a resolution of 0.1%) can be programmed at the front panel, to eliminate drive-unit "hunting" without affecting the controller sensitivity.

A 5-V nominal reference voltage is provided at the rear terminals to energize a drive-unit feedback slidewire.

ON-OFF AND LIMIT CONTROL

Electromax V^{PLUS} instruments can be provided which offer all the advantages of microprocessor circuitry and digital operation for On-Off Control or Overheat or Underheat Limit Alarming. Information is available on request.

PROPORTIONING CONTROL ACTIONS

A full array of control-action adjustments is available as a standard feature of each Electromax V^{PLUS} proportioning controller, permitting you to select a combination and "tune" the instrument to match the dynamics of your process precisely.

On the front panel, behind the drop-down door, are listed the controller parameters: "F1 PROP BAND", "F2 MANUAL RESET", etc. Pressing the "PRGM SELECT" touch-switch sequentially displays the current value of each parameter in the right-hand window, with its identifying key ("F1", "F2") in the left. Releasing the switch holds any selected parameter for modification; other touch-switches are used to increase or decrease the displayed value, and enter it into the controller.

Proportional Action: ("F1 PROP BAND") responds to *how far* the controlled variable moves from set point—operates the final control device in proportion to the deviation. The proportional band has a range of 0.5 to 999.9% of span, with a resolution of 0.1%.

Manual Reset: ("F2 MANUAL RESET") permits returning the process variable to set point after an offset, by directly changing the output; adjustment is 0 to 100% of output span with a resolution of 1%.

Automatic Reset Action: ("F3 RESET") responds to *how far* and *how long* the controlled variable remains off the set point—applies corrective action at a speed expressed as multiples ("repeats") per minute of the proportional-action step-change resulting from the deviation. Range is 0.01 to 99.99 repeats per minute, with a resolution of 0.01 repeat per minute, or—selected by an internal switch—0.005 to 9.999 with a resolution of 0.001, and an "OFF" position.

Rate Action: ("F4 RATE") responds to *how fast* the controlled variable changes. Rate—the reduction in time required to return to set point by adding rate action to proportional action—is adjustable from 0.02 to 5.00 minutes, with a resolution of 0.01 minute, and an "OFF" position.

Lag Action: ("F5 LAG"), or Inverse Rate Action, permits selecting the signal (frequency) of interest in "noisy" processes, filtering out higher frequencies, to provide optimum control with a minimum of valve action. Adjustment is 1.00 to 30.00 seconds, with a resolution of 0.01 second, and an "OFF" position.

Approach Action: ("F6 APPROACH H", "F7 APPROACH L") minimizes setpoint overshoot from either direction when the controlled variable requires time to reach set point; for example, during start-up of a heating process, "F6" applies. Approach action starts the final control device toward its "closed" position ("F6 APPROACH H") or "open" position ("F7 APPROACH L") when the controlled variable reaches a value within the proportional band determined by the Approach setting. Range of adjustment is 0 to 100% deviation, with a resolution of 0.1%.

Dual Tuning Constants: The Electromax V^{PLUS} can be configured to provide two sets of tuning parameters. Transfer from the primary to the secondary set of parameters can be initiated internally, based on the sign of the deviation, or externally by a deviation signal or input alarm relay, through the discrete or serial communications ports.

Preset Output: ("F10 PRESET OUT") permits programming a controller to change to a preset output value when coming back on line after a power failure. This feature is now also available for the P.A.T. output.

SELF-TUNING OPTION

"Tuning" of conventional proportioning controllers for optimum performance on a specific application typically involves the "cut-and-try" adjustment of the three basic PID control actions—Proportional, Integral (reset) and Derivative (rate)—to achieve the desired response of the controlled variable to any deviation from set point.

"Self-tuning", available in Electromax V^PLUS, is a completely new concept: on command, the controller internally perturbs the process, continually refining the PID values on the basis of process reaction until an optimal response can be achieved. When the final values have been identified and displayed, the operator can enter them into the controller as fixed parameters, or enter them and activate a continuous automatic update, for optimum performance under changing conditions.

Initiating the self-tuning operation is a simple push-button procedure at the front panel. Nominal values for proportional, reset and rate actions must be entered. The operator must then bring the process to a stable, typical operating point, with zero deviation, and must also enter values for the process Response Time and for an acceptable Set-Point Upset.

For a detailed description, see Insert Data Sheet C1.1511-IN.

DUAL CONTROL

Electromax V^PLUS can be supplied to provide two control outputs (e.g., one for heating and one for cooling) at the same time, with a common process-variable input and set point but a separate set of tuning parameters for each output. (Self-tuning is not available.) Primary and secondary control actions will be opposite—direct- and reverse-acting control, or vice versa. Control output values will be displayed on the front panel alternately, with a " – " in front of the secondary value. Control combinations available (primary/secondary) are C.A.T./C.A.T., C.A.T./D.A.T., P.A.T./C.A.T., P.A.T./D.A.T. and D.A.T./D.A.T.

ALARMS

Two alarms are a standard feature of each Electromax V^PLUS proportioning controller; each is independently field-adjustable, with a resolution of one degree F or C (or one count) over 0 to 100% of the process-variable span, or 0 to ±100% of the deviation span. The high and low set points of each alarm are digitally set from the front panel like the control parameters previously described. If any limit is exceeded during operation, a red warning legend—"ALM 1" or "ALM 2", or both—will be illuminated.

Optional alarm relays, rated at 5 A on 120 V or 1 A on 240 V, can also be provided, to activate external devices (connected through the terminal board) when alarm settings are exceeded.

CONFIGURATION MODE

The Configuration Mode may be addressed through the menu-select function. The instrument "personality" is developed in this mode, by selection of such items as input linearization type, °C or °F display, remote set-point source, alarm types, reset range, and other parameters, depending upon the features and options selected.

CALIBRATE FUNCTIONS

The same front-panel touch-switches and programming techniques used to set controller parameters are employed to establish calibration values, by calling up functions "C1" through "C16" for display and adjustment. These include the ADC span; slew-rate limit (speed of output change); the high and low values and decimal-point position for scaling a millivoltage or voltage input span; emissivity compensation for direct Rayotube inputs; and high and low limits for the control set point, and for the control output. (If the operator attempts to establish a set point outside the limits, or the input exceeds the limits, the corresponding digital display will flash and the limit value will apply.)

These are one-time settings, at controller start-up, requiring only occasional checking for verification.

REMOTE OPERATION

As an option, a connector can be supplied at the rear of the case to accept digital signals which can initiate changes in controller functions from a remote location. (The 12-V power supply is now included with this option.)

These changes include:

Auto/Manual Transfer: Control can be switched from local automatic to remote manual. Manual output can be increased or decreased from the remote location. Using the "F10 PRESET OUT" touch-switch at the front panel, the controller can be programmed to change to a preset output value when manual operation is remotely actuated, instead of holding at the last (automatic) control output. During a severe process upset, for example, this feature could transfer control to manual and a predetermined safe output value.

Local/Remote Set Point: Set point for automatic control operation can be provided by the controller itself (programmed at the front panel), or as a 0-4 or 1-5 V signal from an external source, through terminals at the rear of the case. (The signal can be scaled to represent from 10 to 100% of the process-variable span.) Switching can be achieved by the "SET PT RMT/LCL" touch-switch on the front panel, or through digital inputs from the remote location. When the controller is switched to the remote set point, an LED and legend ("REMOTE") are illuminated, adjacent to the "PROCESS VARIABLE/SET POINT" touch-switch.

As a standard feature, the local set point (in RAM) can be configured to track the process variable during the remote set-point operation; when the controller is returned to local automatic control, the set point will be set equal to the process variable.

Where DDC backup is required, the addition of the Dual Input feature permits the Electromax V^PLUS to be configured to track the control output and provide bumpless transfer to manual or automatic backup control.

Direct-Acting/Reverse-Acting Control: Control action can be changed from direct to reverse, or vice versa, from the remote location—advantageous, for example, on heating/cooling applications using fuel for heating and a cooling medium.

Panel Lockout: Programming and calibration touch-switch operation can be locked out from the remote location, providing enhanced security for the remote operation. (Auto/Manual and Remote/Local switches are still operational, to provide the operator with override capability during emergency conditions.)

The alternate Serial Communications interface provides remote operation of a full range of instrument parameters.

SELF-DIAGNOSTICS

The Electromax V^{PLUS} controller also includes, as a standard feature, extensive self-diagnostic capability addressable from the front panel by a sequence of touch-switch operations. This capability ranges from a status check of all LEDs, including an automatic segment-by-segment check of the digital displays, to a detailed verification of the circuit integrity.

As an added feature, Alarm #1 ("ALM 1"), if not preempted, can be assigned to provide remote indication of the detection of one of several malfunctions, and can actuate an external alarm through an optional relay. Servicing and maintenance are greatly simplified.

APPLICATION-ORIENTED OPTIONAL FEATURES

Computational software "packages" are available, each offering a choice of process-variable, set-point or control-output modifications to meet specific application requirements. Since each option (with the exception of the Square-Root extraction) preempts two or three input terminals, options within a package are mutually exclusive.

Options available include:

Ratio: Permits accepting inputs from a "wild" and a controlled variable; maintaining the controlled variable in a fixed ratio to the wild variable.

Set-Point Bias: Permits accepting an external signal to bias either the local (internal) set point, or a set-point signal from a remote source.

Ratio with Bias: Permits applying ratio control, with external bias of the set point.

Summer: Permits accepting and algebraically summing two inputs for either the process variable or the set point.

Feedforward: Permits biasing a control-output signal directly, by adding an input signal from an external source. Set point can be local or remote.

Square Root: Permits extracting the square root of the process-variable input signal(s) (e.g., flow from differential pressure).

Mass Flow: Provides mass-flow measurement and control of a gas, utilizing a flow input with compensating pressure and thermocouple temperature inputs (direct or transmitter).

Set-Point Programming: Permits executing a series of ramps and soaks in any combination, with a program comprising up to 10 ramp and soak segments, each adjustable from 0 to 99.99 hours. On/off operation of one or two auxiliary functions (through "ALM 1" and "ALM 2") can be activated at various preset times or process-variable values. "Guaranteed soak" feature is standard. A loop function and internal counter permits repeating from 1 to 10 segments up to 255 times. Program status displays can be viewed at any time.

Dual Control Outputs: Provides two control outputs, split-range, using a common process-variable input and set point. (For details, see "DUAL CONTROL", page 5.)

SPECIFICATIONS

INPUT

Low-Level: Spans from 10 to 100 mV for emf, thermocouple, Rayotube or RTD inputs. Standard thermocouple, Rayotube and RTD ranges are on interchangeable plug-in modules. Linearization and reference-junction compensation are provided where applicable. With a 100-mV range, a controller can also accept the input from an 8888 Linearizer-Plus with a Rayotube or Spectray® heat-radiation detector, and be scaled for direct readout in F or C.

High-Level: Spans of 0-4 and 1-5 V, and 0-16 and 4-20 mA, available for transmitter inputs; linearization is provided for thermocouple and RTD transmitter inputs. High-level spans with linear ranges can also be scaled by the user for direct readout in engineering units.

Input Impedance: 1 megohm minimum.

Thermocouple Failsafe: Upscale or downscale (field-convertible).

Noise Suppression: Although digital equipment is especially sensitive to electrical noise, good wiring practice will normally assure satisfactory Electromax V^{PLUS} operation. In very noisy environments, however, suppression of noise at the source is required, and an optional Noise Suppression Kit is available.

OUTPUT CAPACITY

6011 C.A.T.: 4-20 mA into 0-600 ohms; field-convertible to 0-20 mA into 0-600 ohms, or 0-5 or 1-5 mA into 0-2400 ohms.

6012 D.A.T.: Isolated SPDT Form C contact rated at 5 A on 120 V or 1A on 240 V, 50/60 Hz, resistive load. "OUTPUT" legend on front panel is illuminated during "on" time of cycle.

6013 D.A.T.: Solid-state output from triac, 100 mA to 10 A, 120 V or 240 V, 50/60 Hz. "OUTPUT" legend on front panel is illuminated during "on" time of cycle.

6014 P.A.T.: Solid-state output through two triacs rated at 50 mA to 1.0 A, 120 V or 240 V, 50/60 Hz. On automatic control, "−" or "+" touch-switch on front panel is illuminated when "decrease" or "increase" triac is energized.

NUMERICAL DISPLAY

Process Variable/Set Point: Four digits plus decimal point, in left-hand front-panel display; 7-segment LEDs, covering 100% of range. Resolution, 1°F or C, or 1 count. Pressing "PROCESS VARIABLE/SET POINT" touch-switch selects display; red LED adjacent to "SET POINT" legend indicates when latter display is selected. (A red LED with the legend "REMOTE", adjacent to the touch-switch, lights when controller operates with remote set point.) Pressing "SET PT DECR" or "SET PT INCR" touch-switches below display raises or lowers local set point. The rate of change of set point is logarithmic, to facilitate making both small and large changes.

Output/Deviation: Four digits plus decimal point in right-hand display; 7-segment LEDs, covering 100% of range (output) or ±100% of range or ±9999 degrees (deviation). Resolution, 1% for output, 1°F or C or 0.1% for deviation. Pressing "OUTPUT/DEVIATION" touch-switch selects display; red LED adjacent to "DEVIATION" legend indicates when the latter display is selected.

Displays are also used, in conjunction with touch-switches, to present values of functions during programming and calibration procedures.

AUTO/MANUAL TRANSFER

Local: Bumpless/balanceless transfer from automatic to manual control, and vice versa, through touch-switches on front panel. Red LED behind Auto/Manual switch lights in the manual mode; adjacent " – " and " + " switches can then decrease or increase control output, at a logarithmic rate of change.

Remote: Remote transfer option permits switching controller from automatic to manual and back, with a manual output equivalent to (1) the last automatic-control output level, or (2) a Preset Output value programmed at the front panel. This option also permits (from the remote location) increasing or decreasing the manual output, switching to a remote set point for automatic control, switching to either reverse- or direct-acting control, or locking out panel-switch changes for security.

TUNING ADJUSTMENTS: Programmed by touch-switches at the front panel; include:

Proportional Band: 0.5 to 999.9% of input span; resolution, 0.1%

Manual Reset: For proportional-only control operation; OFF and 0 to 100% of output span; resolution, 1%.

Automatic Reset: OFF and 0.01 to 99.99 repeats/minute, with a resolution of 0.01 repeat/minute, or 0.005 to 9.999 repeats/minute with a resolution of 0.001 repeat/minute.

Rate: OFF and 0.02 to 5.00 minutes; resolution, 0.01 minute.

Lag Time: OFF and 1.00 to 30.00 seconds; resolution, 0.01 second.

Approach: Two independent adjustments, for increasing and decreasing process variable: 0 to 100% of deviation; resolution, 0.1%.

Impulse Rate (D.A.T.): 1.0 to 20.0 cycles/minute; resolution, 0.1 cycle/minute.

Drive-Unit Sensitivity (P.A.T.): 80 to 100% of output; resolution, 0.1%.

REFERENCE-VOLTAGE OUTPUT: Provided for use on a drive-unit feedback slidewire (P.A.T. control) or a remote set-point or bias potentiometer: 5 V d-c nominal, for a 100- to 1000-ohm slidewire.

PERFORMANCE SPECIFICATIONS

Accuracy: Factory-calibrated to ±0.25% of input span, for all ranges.

Field-calibratable for thermocouple ranges, at reference conditions to:

±1°F or C for base-metal Type E, J, K, N or T;
or

±2°F or C for noble-metal Type B, R or S, W5RE/W26RE or Ni-Ni, 18% Moly.

The calibration procedure is described in the Operator's Manual.

Temperature Stability: 6 μV per degree C maximum, including reference-junction compensation. A detailed specification referring to individual thermocouple types is provided in the Operator's Manual.

Common-Mode Rejection: At reference conditions: 120 dB at 60 Hz for low-level input; 80 dB at 60 Hz for high-level input.

Normal-Mode (Transverse) Rejection: 50 dB at 60 Hz, for low- or high-level process variable input; 40 dB at 60 Hz, for auxiliary high-level input (remote set point).

OPERATING SPECIFICATIONS

Reference Conditions: Temperature: 25 C (77 F). Relative humidity: 40%. Supply voltage: 120 V, 60 Hz (or 240 V, 50 Hz). Source resistance: 10 ohms.

Rated Conditions: Temperature: 4 to 55 C (40 to 131 F). Relative humidity: 90% at 40 C, non-condensing. Vibration: 5 to 60 Hz at 1 g. Shock: Up to 1 g for 30 msec. Supply voltage: 120 V ±10%, 50/60 Hz (or 240 V ±10%, 50/60 Hz). Source resistance, 2000 ohms, max.

Extreme Conditions: Temperature: 0 to 60 C (32 to 140 F). Relative humidity: 50% at 60 C, non-condensing. Vibration: 5 to 60 Hz at 0.2 g. Shock: Up to 5 g for 30 msec.

Storage Ratings: Temperature: –10 to 70 C (14 to 160 F). Vibration: 50 to 60 Hz at 0.5 g. Shock: Up to 10 g for 30 msec.

ALARMS: Two independently-set dual alarms are provided as a standard feature: HI/HI and LO/LO operation for either the process-variable or the deviation value, or HI/LO operation for each value. (Assignment of alarms is switch-selectable.) LED-illuminated legends—"ALM 1" and "ALM 2"—indicate when each alarm has been tripped. Range of alarm setting (programmed by touch-switch) is 0 to 100% of process-variable span, or 0 to ±100% of deviation span. Resolution is 1° F or C, or 0.1%; hysteresis, 0.25% of span.

As an option, two SPDT Form C relays (Part Number 036766), energized on alarm trip in either direction, can be provided to actuate external devices; contact rating, 5 A at 120 V or 1 A at 240 V, 50/60 Hz.

TERMINAL CONNECTIONS: Connection of field wiring is made to #6 screw barrier terminals on a board inside the rear cover of controller. A cable within the case joins the dedicated terminal board to the slide-out controller chassis with a removable plug-in connector.

For isolated discrete digital inputs for remote operation, an optional connector can be provided at the rear of the case. For serial digital communication, an optional RS422/485 Interface can be provided at the rear of the case.

CONSTRUCTION

Front Panel: Comprises a monoplanar, dust-tight, non-glare switch panel, with opaque black background; transparent "windows" are provided for illuminated displays, labelled gray areas to identify touch-switches. Programming parameters ("F1 PROP BAND", etc.) are listed on panel, in program sequence. Hinged drop-down cover conceals programming switches when not in use; duplicate list of parameters (on inner surface of cover) permits notation of selected settings.

Chassis: Slide-out steel chassis can be removed from the front without disconnecting field wiring.

Terminal Board Cover: Finned cast aluminum; also functions as heat-sink for triac outputs up to 10 A.

Case: Cast-aluminum case is designed for mounting from front of panel, with self-contained mounting hardware. Front bezel dimensions (DIN): 144 mm (w) x 144 mm (h) (5.7" x 5.7"); case, 136 mm (w) x 136 mm (h) (5.35" x 5.35"), and 305 mm (12") deep, behind bezel. Panel cutout requirements 138 x 138 mm (5.43" x 5.43").

Panel Cutout Measurements: 5.438 + or – .031 inches square. Average Unit Weight: 12 lbs.

Average Unit Weight: 12 lbs.

HOW TO ORDER

Specify appropriate suffixes to complete the catalog number.

A B C D E F G H
601 ☐ - ☐ - ☐☐ - ☐ - ☐ - ☐☐ - ☐☐ - ☐☐☐ - ☐☐☐

Suffix A. Model

Current-Adjusting-Type Controller	**6011**
Duration-Adjusting-Type Controller (Relay)	**6012**
Duration-Adjusting-Type Controller (Triac)	**6013**
Position-Adjusting-Type Controller	**6014**

Suffix B. Input*

Single Input (Non-Isolated)	**3**
Dual Input (Non-Isolated)	**4**
Dual Input (Isolated Low-Level)	**5**

Suffix C. Range

See Range Table for Suffix	☐☐

Suffix D. Power Requirements

120 V, 50/60 Hz	**1**
240 V, 50/60 Hz	**2**

Suffix E. Self-Tuning**

None	**0**
Self-Tuning Capability	**7**

Suffix F. Application Packages

None		**00**
Package "A": User-Selectable Choices of Ratio; Summer on Set-Point; Ratio with Set-Point Bias; Summer on Process Variable; Feedforward; Mass Flow; Square-Root Extraction		**30**
Package "B": User-Selectable Choices of Summer on Set-Point; Summer on Process Variable; Feedforward; Set-Point Programming		
With Single Control Output		**40**
With Dual Control Output (Heat/Cool):		
Primary Output***	Secondary Output	
C.A.T., P.A.T. or D.A.T.	C.A.T.	**41**
C.A.T. or P.A.T.	D.A.T. (Relay)	**42**
D.A.T. (1A, 120V Triac)	D.A.T. (1A, 120V Triac)	**43**
Package "B1": User-Selectable Choices of Analog Input Summed with Setpoint or Process Variable; Setpoint Programming with Selectable Summation of Program Setpoint with Analog Input and/or Local Setpoint.		
With Single Control Output		**50**
With Dual Control Output (Heat/Cool):		
Primary Output***	Secondary Output	
C.A.T., P.A.T. or D.A.T.	C.A.T.	**51**
C.A.T. or P.A.T.	D.A.T. (Relay)	**52**
D.A.T. (1A, 120V Triac)	D.A.T. (1A, 120V Triac)	**53**

Suffix G. Digital Communications

None	**00**
Discrete	**01**
Serial (RS422/485)	**02**

Suffix H. Options

None	**000**
Alarm Relays Installed (For "ALM 1" and "ALM 2")	**100**
4-20 mA Output Proportional to Process Variable,**** Deviation, Set Point or Output (Software-Selectable)	**103**
C.A.T. Manual Station (P/N 074825)	**105**
P.A.T. Manual Station (P/N 074826)	**106**
Noise Suppression Kit	**110**

**Dual-input option—required for Ratio with Set-Point Bias, Mass Flow, Summer or Feedforward functions—permits accepting two inputs: one low- or high-level, one high-level, both non-isolated (B-4), or one isolated low-level, one non-isolated high-level (B-5).*

***Self-tuning is not available with dual control-output options F-41, F-42, F-43, F-51, F-52 or F-53.*

****Primary control-output type is specified by Suffix A.*

*****Option 103 is not available with secondary C.A.T. output; Suffix F-41.*

Range Table

Sensor	Type	Range	Module Part No.	Suffix Number
Thermocouples	B	120 to 3300 F (48 to 1816 C)	046352	01
	E	−450 to 2200 F (−268 to 1204 C)	064299	28
	Ni-Ni, 18% Moly	0 to 2500 F (−18 to 1371 C)	046366	02
	J	−250 to 2000 F (157 to 1093 C)	046353	03
	K	0 to 2500 F (−18 to 1260 C)	046354	04
	N	0 to 2372 F (−18 to 1371 C)	046355	05
	R	0 to 3100 F (−18 to 1704 C)	046356	06
	S	0 to 3200 F (−18 to 1760 C)	046357	07
	T	−250 to 750 F (−157 to 399 C)	046358	08
	W5RE/ W26RE	0 to 3980 F (−18 to 2193 C)	046359	09
Resistance Thermometers	100 Ohm Pt*	−290 to 1500 F (−179 to 816 C)	046360	10
	25-Ohm Pt	0 to 1000 F (−18 to 538 C)	046361	11
	100-Ohm Cu	−320 to 300 F (−196 to 149 C)	046362	12
Rayotube Detectors	18890	0 to 24 mV 0 to 10 mV	046368 046369	17 18
Variable Scaling	Low-Level Input	−5 to +5 mV 0 to 10 mV 0 to 20 mV 0 to 100 mV	046367 046363 046364 046365	16 13 14 15
	High-Level Input**	0 to 4 or 1 to 5 V 0 to 16 or 4 to 20 mA		20 21
Spectray	8886-1 8886 8885-2	1300-2900F (704-1593C) 2600-3500F (1427-1927C) 800-1500F (427-806C)	056473 056474 056475	29 30 31
Rayotube Detectors	18874-0578 18875-0580	482-2552F (250-1400C) 302-2552F (150-1400C)	— —	33 34
Radiamatic	Low Range High Range	1200-2600F (649-1427C) 1800 3300F (983-1816C)	056471 056472	35 36
Rayotube Detectors	18890-0163 18894-0579	200-1400F (93-760C) 752-3200F (400-1760C)	046369 046369	37 38
Fibéray	0590 0591	1454-2372F (790-1300C) 2142-2912F (1190-1600C)	— —	39 40

**Range is for sensors with an International (DIN Specification) temperature coefficient, 0.00385 ohm/ohm/°C.*

***Zero suppression of input range is selected by configuration programming. For the milliampere range ("21"), a 250-ohm shunt is supplied for mounting on the rear terminal board*

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L&N Stations for Backup Control

General

C1.1701-DS

Leeds & Northrup Instruments offers both the lowest priced manual backup control station and the most comprehensive automatic backup control station.

Current Output *Motor Position Output*

Manual Backup Control Stations

- **Low-cost security against process shutdown with an L&N Manual Backup Control Station.**
- **Backup control for Programmable Logic Controllers, Digital Controllers, or other P.I.D. proportional control instrumentation.**
- **Control Stations can aid process startup and shutdown, and be of value during process emergencies.**

Whether because of financial considerations or a perceived low likelihood of failure occurring, many industrial processes being automatically controlled by digital controllers or programmable logic controllers have no backup incorporated in the control loop. Yet, significant losses could be sustained due either to ruined product, protracted downtime, or catastrophic damage should the automatic controller fail to function properly.

continued on Page 3

1 196.
6 0
LEEDS & NORTHRUP INSTRUMENTS

Electromax V^{PLUS} Automatic Backup Control Stations

- **Full P.I.D. proportional control redundancy with bumpless transfer.**
- **Output tracking *plus* setpoint tracking of process variable.**
- **Automated transfer from primary controller to backup controller.**

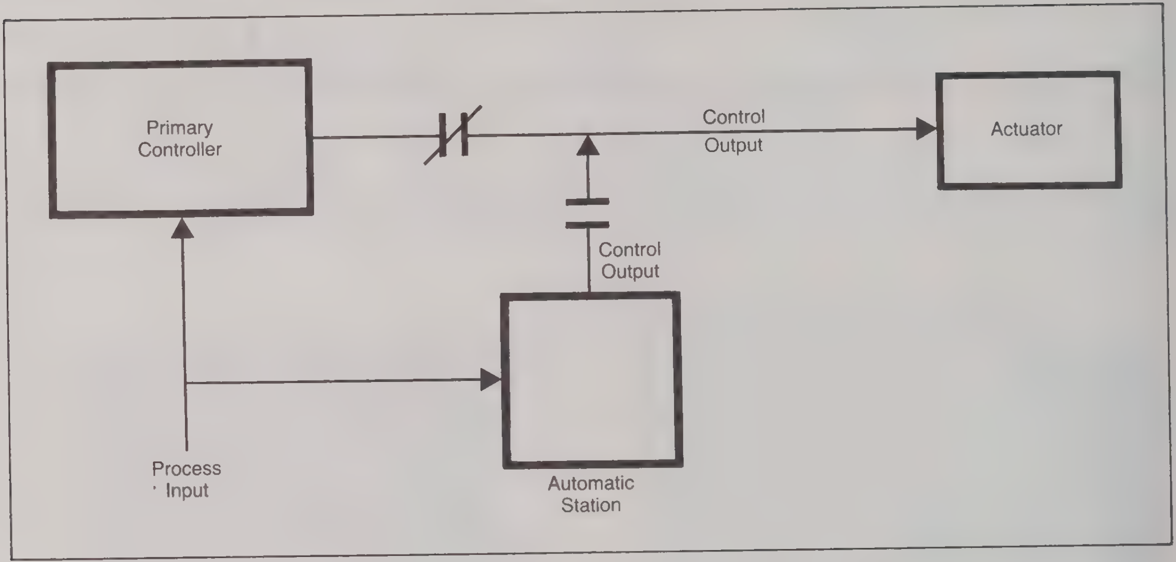
Many P.I.D. control applications require more than simple manual backup due to process dynamics or the critical nature of the process. Where the sensitivity of the process or the extent of potential loss dictates that the controller backup be able to provide a smooth and bumpless transfer and enable an operator to continue to make setpoint and output adjustments, the Electromax V^{PLUS} Automatic Backup Control Station offers full capabilities.

continued on Page 2

LEEDS & NORTHRUP INSTRUMENTS
A UNIT OF GENERAL SIGNAL

We put you in control.

Electromax V^{PLUS} Automatic Backup Control Stations *continued*

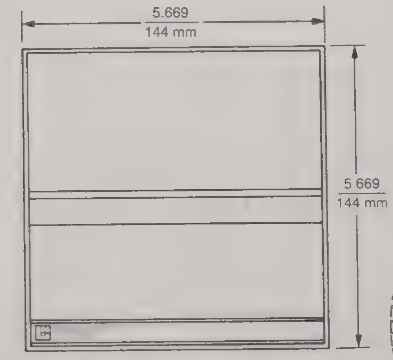


One example of where automatic backup control is indicated is where an extended period of time has elapsed since the last failure and the operator may not recall the process details well enough to maintain control manually. Another is where the process is under computer control and more sophisticated backup with setpoint adjustment capability is called for. Still another is where the process is such that even a slight shift in the process would be disruptive, so that bumpless transfer is required. In these and similar situations, fully automatic backup control is the answer.

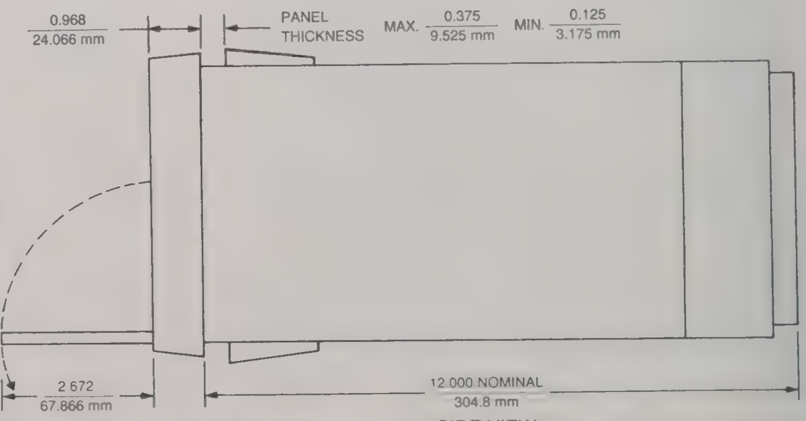
An Electromax V^{PLUS} Automatic Backup Control Station can track the primary controller's output (whether from a single-loop controller, a distributed control system or a digital computer), the process variable and the status of the primary controller. During normal operation, the Electromax V^{PLUS} Control Station is in a forced manual/remote setpoint mode, tracking both the primary controller's output and the process variable under control. Upon failure of the primary controller, an external contact is tripped and the Electromax V^{PLUS} Control Station assumes full P.I.D. control without any process bump, whether the control action is current-adjusting or position-adjusting. The output will remain the same as the primary controller's at the time of failure, and the station's setpoint will match the value of the process variable. The operator can then make setpoint and/or output adjustments as required using the Electromax V^{PLUS} Control Station, just as he would with the primary controller. The Electromax V^{PLUS} Controller provides the most comprehensive and non-disruptive control transfer achievable, and is the preferred alternative when basic manual backup control is inadequate for the application.

For a complete product description of the Electromax V^{PLUS} Controller, refer to Data Sheet C1.1511-DS. To utilize the controller's automatic backup control functions requires that you specify the following two options: 1. Dual Input (non-isolated). 2. Discrete or Serial Communications

Dimensions



FRONT VIEW

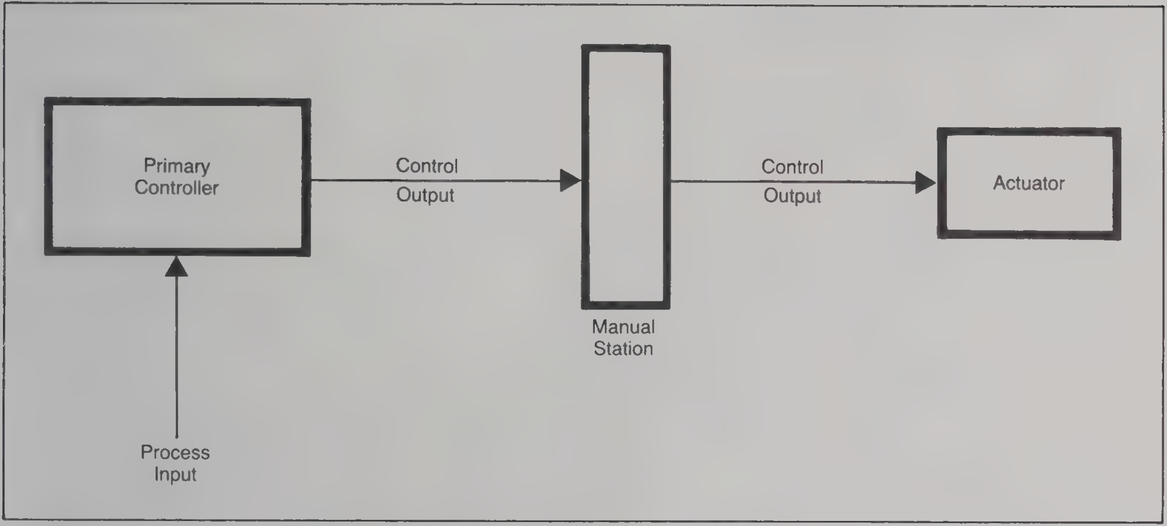


SIDE VIEW

Panel Cutout

Standard Mounting	5.438 ± 0.031 138.13 ± 0.787 mm	×	5.438 ± 0.031 138.13 ± 0.787 mm
DIN Mounting	5.433 +0.039, −0 138 +1, −0 mm	×	5.433 +0.039, −0 138 +1, −0 mm

Manual Backup Control Stations *continued*



While the greater reliability of today's modern control equipment does afford a good measure of security, the possibility still exists of a microprocessor malfunction or some other failure in the controller. With the new L&N Manual Backup Control Stations, essential backup security to save the process from going down is available at a cost so low it becomes practical to add it to any automatically controlled operation. The savings realized the first time it's needed will more than pay for the unit.

In addition, the Manual Backup Control Station can be useful during process startup and shutdown, or in the event of a process emergency. The automatic primary controller may be installed in a central control room remotely located from the process. Under such conditions, having an L&N Manual Backup Control Station near at hand allows an operator to manually regulate the control element during startup or shutdown. Or to quickly assume manual control should a process upset occur. The station also permits the primary controller to be removed for periodic maintenance without requiring the process be shut down.

Compact Station/Two Versions

Housed in a DIN-sized molded plastic case designed for quick and easy panel mounting, a Manual Backup Control Station provides basic process control security through a "hard manual" output to the final control element. Two versions of the station are available: one supplies a current output and is employed for end elements such as electro-pneumatic converters or SCR power packages, the other provides a motor position output via raise/lower contacts for regulating electric drive units.

Once integrated into the control loop with the primary controller and the final control element, the Manual Backup Control Station, through a pushbutton switch on its face panel, permits the control output to be determined by either the automatic controller or the manual station. An indicating light above the pushbutton glows green when in the automatic mode, and red when the manual mode is selected. A meter graduated 0-100 displays the % output to the end element in both modes.

Wherever simple manual backup control of a process is indicated, the L&N Model 074825 and 074826 Stations are the instruments of choice, providing basic security at a minimum price. These low-cost units can also be employed within a plant to permit local manual positioning of drive units, I/P converters and other end elements, either as "stand alone" manual controllers or as supplements to control actions initiated from a centrally located control room.

Current Output Station

The Model 074825 Manual Backup Control Station, designed for current output, offers selectable current ranges of either 0-5 mA or 0-20 mA, with 25% offset adjustment from zero or full scale to obtain 1-5 mA or 4-20 mA outputs. A balance key and a control knob on the face panel enable an operator to adjust the output from the station to match the output from the primary controller before switching over from automatic to manual operation. By depressing the balance key (located below the Auto/Manual switch) and rotating the control knob (located below the meter), the operator can position the manual station output so as to duplicate the automatic controller output. Once in the manual control mode, the station provides an isolated, Form C, manual-automatic status contact output to signal the primary controller the change in control mode. The loop output is isolated from the controller, so that any further positioning of the final control element which is required is carried out using the manual station's control knob. High and Low trimming potentiometers, screwdriver accessible through the face panel, permit adjustment of the meter readout to match high and low end output.

Motor Position Output Station

The Model 074826 Manual Backup Control Station, designed for control loops using electric drive units, displays on its % output meter the actual drive unit position as sensed by a feedback slidewire input to the station. The drive unit slidewire voltage—selectable from 0.5V, 5V or 15V to match slidewire voltage supplied by the primary controller—is displayed in both automatic and manual

continued

control modes, making the switchover to manual a bumpless transfer. When in manual operation, the drive unit travel is regulated via a raise/lower rocker-type switch located below the meter. A true-position measurement is indicated since the position signal is actuated directly from the drive unit's output shaft, making precise manual control possible. Along with the high and low potentiometer adjustments available for the meter is an additional trimpot used to balance the feedback slidewire power supply of the manual station to match the power supply of the primary controller.

MANUAL BACKUP CONTROL STATION SPECIFICATIONS

GENERAL SPECIFICATIONS

Accuracy
Manual mode: Meter to Output—2.5% of span ±.25% per °C.
Automatic mode: Meter—2.5% of span ±.25% per °C. Output—Primary controller accuracy applies.

Radio Frequency Interference: Less than 0.5% output disturbance at a distance of 1 meter (3.1 ft.) from front of unit. (27 MHz at 4 Watts) (154 MHz at 5 Watts) (461 MHz at 5 Watts)

Rated Operating Conditions:
Temperature—4°C to 55°C (40°F to 131°F).
Relative Humidity—90% at 40°C, non-condensing.
Vibration—5 to 60 Hz at 0.1G.
Shock—Up to 1 G for 30 ms.
Supply Voltage—120/220 VAC ±10%, 47 to 63 Hz.

Dimensions: 5.7″ H × 1.9″ W × 5.5″ D (144 mm × 48 mm × 139 mm).

Weight: 19 oz. (0.53 kg).

Mounting: Via clamps at top and bottom onto panels from ⅛″ to ¾″ thick.

MODEL 074825 SPECIFICATIONS

Current Output Ranges: 4 to 20 mA into 0 to 600 ohm load. 0 to 20 mA into 0 to 600 ohm load. 1 to 5 mA into 0 to 2400 ohm load. 0 to 5 mA into 0 to 2400 ohm load.

Insertion Loss: Current Output Station requires 2.1 Volts from current loop for meter circuit.

Meter Display: Primary controller or station output from 0 to 100% of adjusted span.

Manual Output Control: Ten-turn control knob.

Balance Key: Permits adjustment of manual station output to match primary controller output.

Calibration: Meter can be adjusted to 25% of span from upper and lower limits via High and Low trimpots in order to match high and low end outputs.

Current Output Ranges: 0 to 5 mA or 0 to 20 mA as selected, with 25% offset adjustment from zero or full scale. Minimum 3% overrange adjustment available at span limits with 25% span offset.

MODEL 074826 SPECIFICATIONS

Motor Position Output: Output Drive—50 mA to 1 Ampere at 120/240 VAC, 50/60 Hz.
Slidewire Loading—100 to 1000 ohms.

Meter Display: True position of drive unit in % of span.

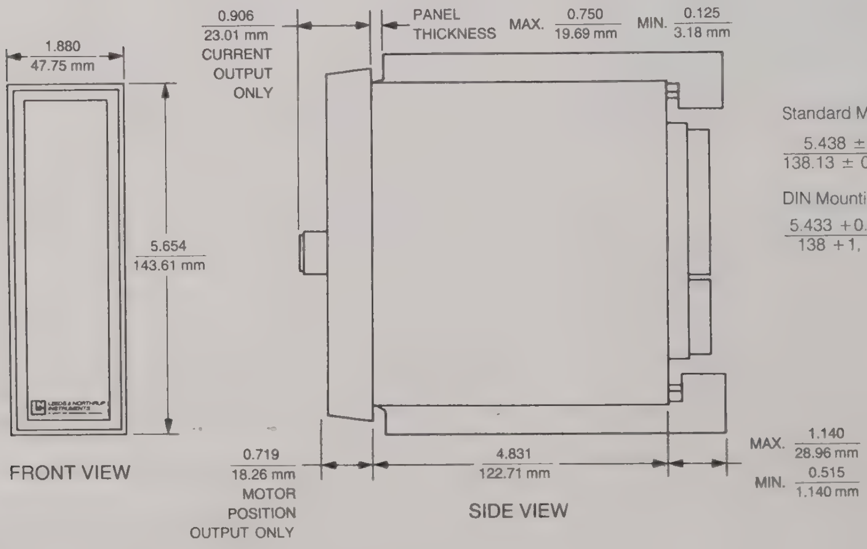
Manual Output Control: Double-throw rocker-type switch with spring return.

Calibration: Meter can be adjusted to 25% of span from upper and lower limits via High and Low trimpots in order to match high and low end outputs. The station's slidewire power supply output can be matched to that provided by the primary controller via a Balance trimpot.

Drive Unit Slidewire Voltages: 0.5 V, 5V, or 15V as selected to conform to the slidewire voltage supplied by the primary controller.

All specifications subject to change without notice.

Dimensions



Panel Cutout

Standard Mounting

$\frac{5.438 \pm 0.031}{138.13 \pm 0.787 \text{ mm}} \times \frac{1.750 \pm 0.031}{44.45 \pm 0.787 \text{ mm}}$

DIN Mounting

$\frac{5.433 +0.040, -0}{138 +1, -0 \text{ mm}} \times \frac{1.772 +0.024, -0}{45 +0.6, -0 \text{ mm}}$

LEEDS & NORTHRUP
INSTRUMENTS North Wales, Pa. 19454
A UNIT OF GENERAL SIGNAL

We put you in control.

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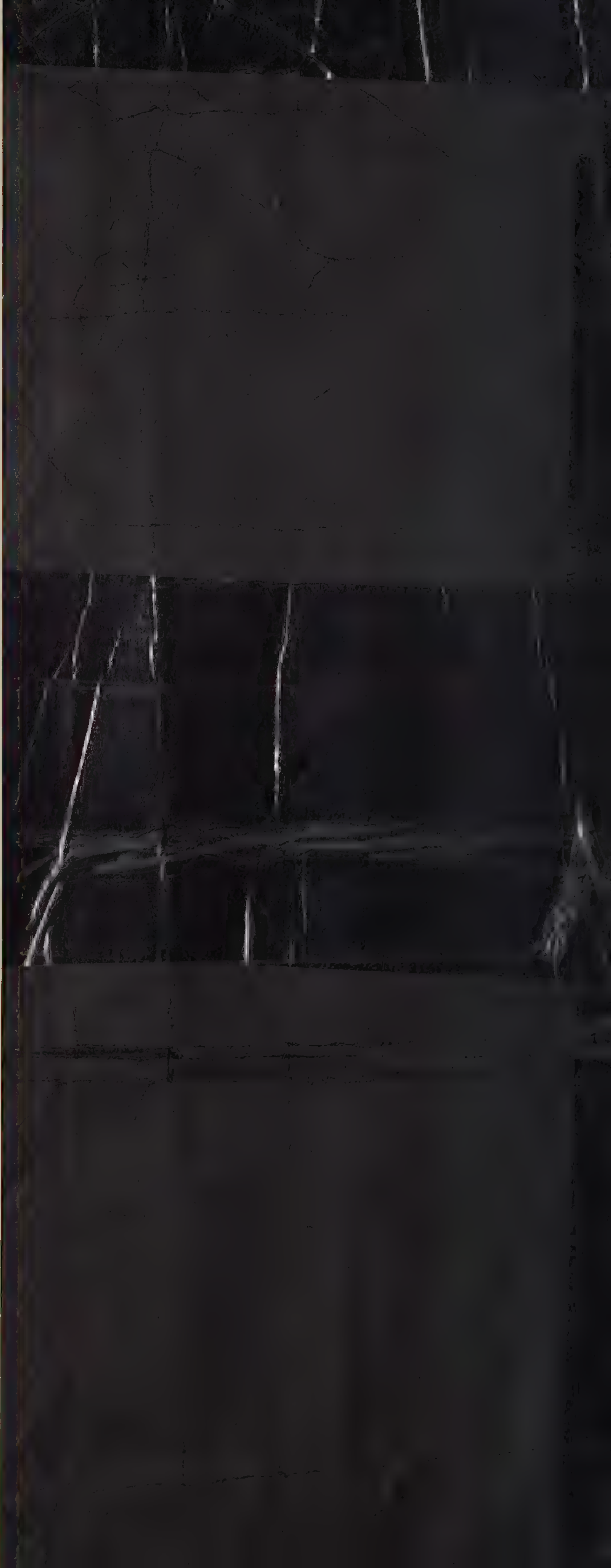
Leeds & Northrup 1300 Process Programmer

adds powerful programmable
logic control to basic
set-point programming
... at your fingertips.

1300 process programmer
LEEDS & NORTHRUP
14
2250
DIGIT
SET POINT
ELAPSED TIME
REGION
HRS X 100
EVENT
HOURS
EVENT
INPUT
NOT
MINUTES
EVENT
INPUT
NOT
OUTPUT 1
OUTPUT 2
HOLD 1
HOLD 2
7
8
9
START
VALUE
OPER
PRGM

Leeds & Northrup 1300 Process Programmer

- Program the time/temperature cycle desired in minutes. Unique guided programming leads you through step-by-step.
- Program process logic control functions. The 1300 Process Programmer will accept contact-closure inputs and logically combine them with internally generated time or set-point related events, to produce contact-closure outputs.
- Select virtually any controller. Built-in sensor curves and programmable range limits let you choose a controller without compromising.
- Run two individual programs simultaneously from a single 1300 Process Programmer. Make them interrelated or independent.
- Change programs in seconds by means of plug-in Program Storage Modules. As simple as changing a tape cassette.



1300 Process Programmer enables you to program your process quicker than ever, better than ever.

Leeds & Northrup's 1300 Process Programmer is a microprocessor-based instrument which generates a set-point signal that varies according to a pre-set program. A pattern of "ramps" and "soaks" which have been entered into the 1300's memory through a programming keyboard is reflected in the signal sent to an electronic controller regulating final process control devices.

Programming the 1300 involves sectioning a process into a series of "regions"—time periods in which the operation is either in a static condition (a soak) or a changing condition (a ramp). Set points for these regions are individually entered utilizing a guided programming feature which reduces the procedure to a simple series of steps which are prompted by flashing lights.

The L&N 1300 Process Programmer provides superior performance by combining the greater capability and flexibility of two independent set points and associated logic control. Performance not achievable in older analog programming instruments or even in current digital programmers.

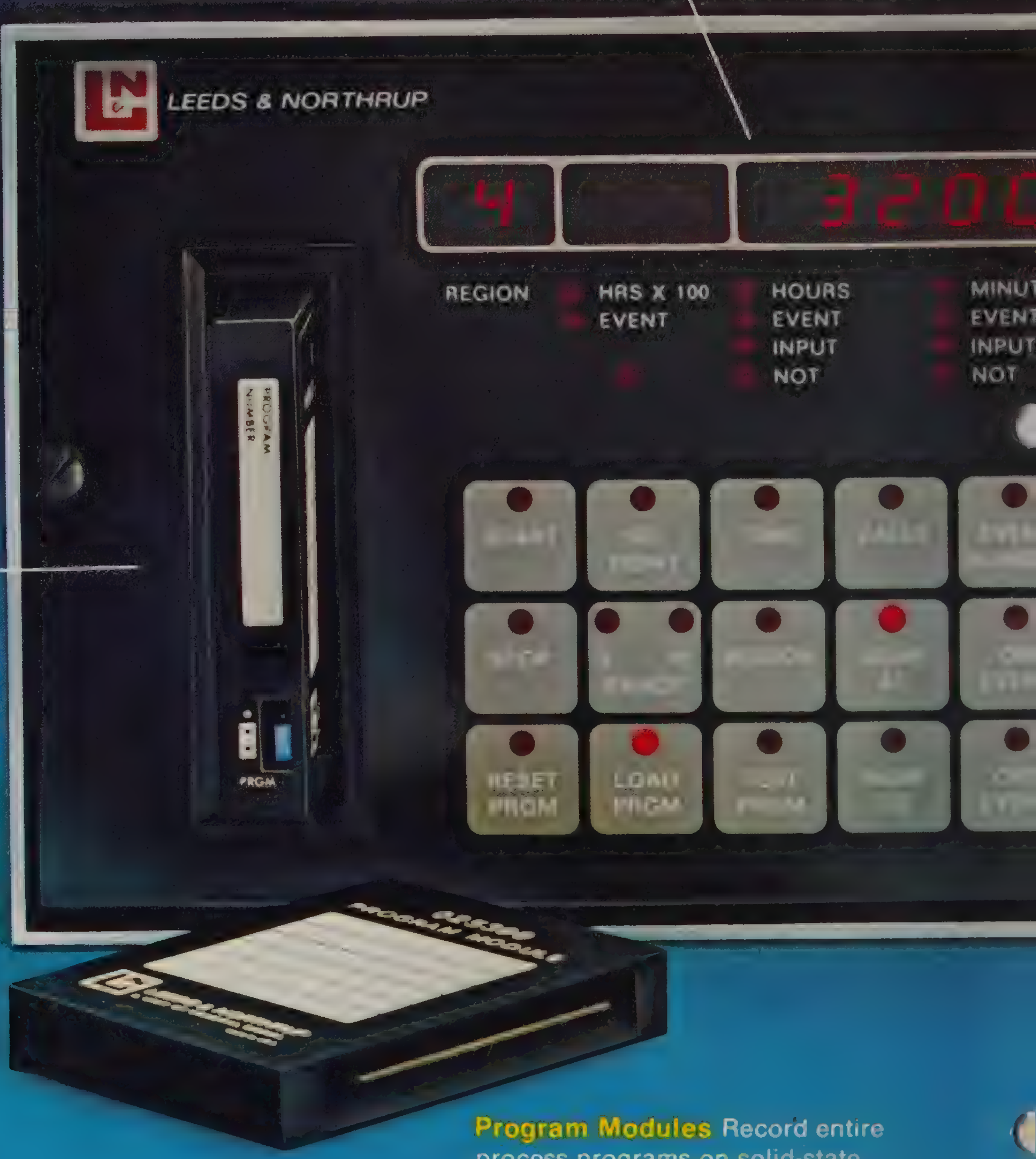
The 1300 Process Programmer not only accepts a time sequenced program of set points to regulate the controller, but also accepts a program of logic "events" which affect the process. Inputs in the form of contact closures related to on-off status of fans, pumps, dampers, doors, etc., can be integrated into the program. For example, a soak can be terminated upon an event such as a fan shutting off, rather than at the end of a specific time period. Time or set-point related events can either be independent of, or interrelated with, process logic events. And whether programmed to act alone or in combinations, these events can generate contact closure output signals. Thus, a valve might be activated at the end of a specified period *if* the set point has reached a certain value *and* a damper has been opened. This and/or/not logic applied to time or set-point related events offers the user unmatched capability in maintaining total control over his process.

Contributing to the flexibility of the 1300 is the fact that it can be used with almost any analog controller, since the output signal can be supplied as a 0-5 volt, 0-10 volt, 0-15 volt, 1-5 volt, 4-20 mA, or 0-20 mA signal. These signals may be linear or characterized to match the thermocouple used by the controller. The 1300 Process Programmer has C° and F° curves for type B, J, K, R, S, T, and W5 (Tungsten-Rhenium) thermocouples permanently stored in memory. Optional modules are available to substitute up to three curves in the 1300 Programmer's memory for other sensors. One set-point output can feed several controllers. The controllers may be single-loop, ratio-control or cascade-control configurations.

Leeds & Northrup 1300

Digital Display Digital readout displays setpoint value in engineering units, region identification, program time and logic statements.

Program Module Access Accepts plug-in program modules to transfer programs to or from the process programmer.

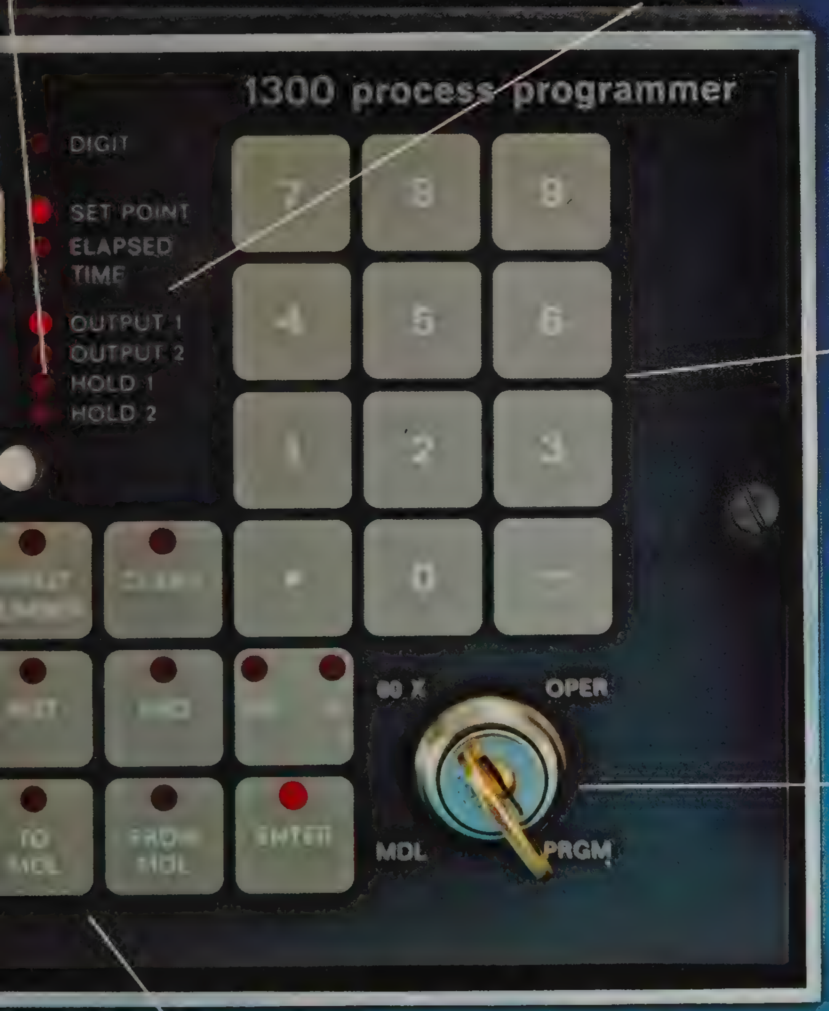

LEEDS & NORTHRUP
4
3200
REGION
HRS X 100
EVENT
HOURS
EVENT
INPUT
NOT
EVENT
INPUT
NOT
PROGRAM NUMBER
PRGM
RESET PRGM
LOAD PRGM
PROGRAM MODULE

Program Modules Record entire process programs on solid-state program storage modules. Reload programs in seconds from an unlimited library of modules.

Process Programmer

'Hold'' Indicators LED's flash independently vhen either of the two process programs are utomatically placed in a ''hold'' status to ermit the process variables to reach the pro-rammed value.

Legend Indicators Dual-function LED's light up to indicate legend information for the displayed digits, and flash to guide you in programming.


1300 process programmer
DIGIT
SET POINT
ELAPSED TIME
OUTPUT 1
OUTPUT 2
HOLD 1
HOLD 2
7
8
9
4
5
6
1
2
3
.
0
—
60 X
OPER
MDL
PRGM
TO MDL
FROM MDL
ENTER

Numeric Keyboard Enter program data directly in engineering units through numeric section of keyboard.

Keyswitch In addition to providing system security, the four-position keyswitch is used to select either operating or programming modes. For programming, use the PRGM position to enter a program through the keyboard or use the MDL position to transfer a program to or from a program module. For normal operation, use the OPER position. To quickly verify a program, use the 60X position.

Operating & Programming Keys Indicator lights on each key flash to guide you in programming or operating your process. Steadily lit LED's identify the current program step or operating mode.

1·2·3 Programming

Programming the 1300 Process Programmer is a simple procedure because of the unique guided programming feature. Each touch switch key on the monoplanar front panel is backlighted with an LED which will either be off, steadily lit or flashing. Steadily lit keys indicate the current program step, flashing keys indicate the choices available for the next program step. This combination of "status" keys and "prompting" keys leads the programmer through the procedure in an easy to follow, step-by-step sequence.

For example: an operator segments his process into time periods (called "regions"). In each of these regions, the set point is raised or lowered at a selected rate (a "ramp"), or it is held at a certain value for a specific time (a "soak"). The operator selects the region key on the front panel and enters the number of the region to be programmed (0-15). At this point, two other keys flash—SOAK AT and RAMP TO—indicating that either function may be selected.

If he depresses the SOAK AT key, it will light steadily and the light on the RAMP TO key will go off indicating the selection has been accepted. Simultaneously, the LED indicator labeled DIGIT will flash informing the operator that the numeric soak value should be entered using the numeric key set. Once he has entered the soak value and depressed the ENTER key, his next programming step will be indicated by other flashing keys. In this example, the TIME and EVENT NUMBER keys flash, requesting the operator to terminate the soak as a function of time or by a logic event. In this manner, the operator is guided through each step as he enters either one or two programs, with all the associated ramps and soaks, logic events, values and input and output assignments.

1300 process progra
REGION
HRS X 100
EVENT
HOURS
EVENT
INPUT
NOT
MINUTES
EVENT
INPUT
NOT
SET POINT
ELAPSED
TIME
OUTPUT 1
OUTPUT 2
HOLD 1
HOLD 2

Enter your range limits right on the keyboard

Keyboard entry of range limits enables you to match the 1300 Process Programmer to virtually any controller right in the field. You're not locked in to a specific range or thermocouple which would limit your choice of controllers.

1300 p
287
DIGIT
SET POINT
ELAPSED
TIME
MINUTES
EVENT
INPUT
NOT
OUTPUT 1
OUTPUT 2
HOLD 1
HOLD 2

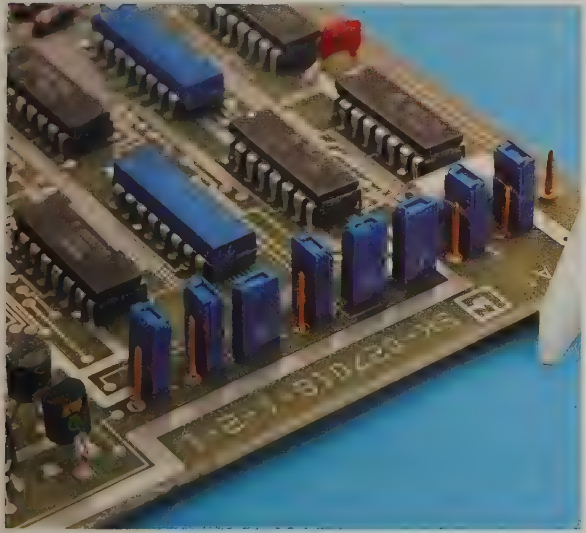
"Hold" function guarantees temperature

Independent "Hold" function for each set-point uses deviation contacts in controller to hold the program until a lagging process can catch up.

1300 process program
DIGIT
SET POINT
ELAPSED TIME
REGION
HRS X 100
EVENT
HOURS
EVENT
INPUT
NOT
MINUTES
EVENT
INPUT
NOT
OUTPUT 1
OUTPUT 2
HOLD 1
HOLD 2

Program logic control functions

Enter time-related or value-related events. Then combine them with inputs from the process in a logic pattern (AND/OR/NOT) to produce contact closures when and where you need them.



Change thermocouple type by simply moving jumpers

The operator can select any thermocouple curve desired by simply rearranging plug-in jumper blocks.

LEEDS & NORTHRUP
DIGIT
SET POINT
ELAPSED TIME
REGION
HRS X 100
EVENT
HOURS
EVENT
INPUT
NOT
MINUTES
EVENT
INPUT
NOT
OUTPUT 1
OUTPUT 2
HOLD 1
HOLD 2
PROGRAM MODULE

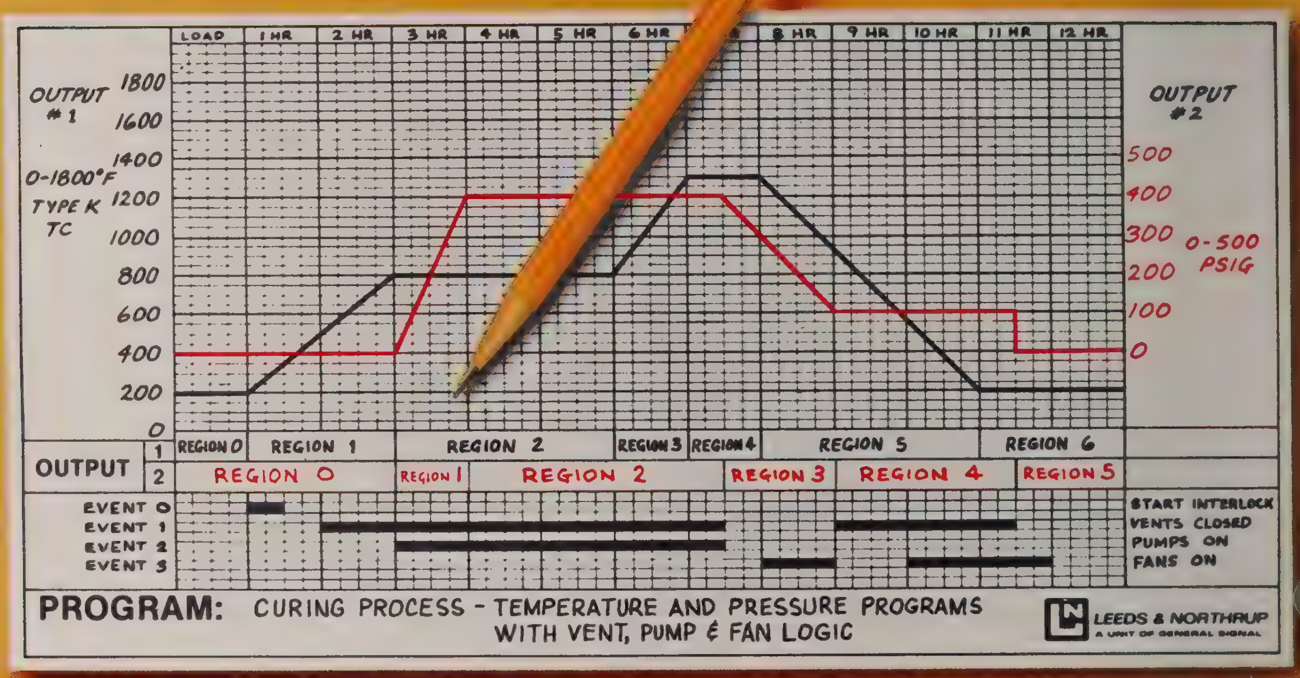
Change programs with "cassette" simplicity

The program storage capability of the 1300 Process Programmer is particularly useful when frequent program changes are common to a process, or programs must be switched back and forth depending on the load.

Once a program has been entered into the Process Programmer, it is stored internally in a CMOS RAM for use by the microprocessor in executing the program. Program modules are available which can be inserted into the Programmer much as a cassette is plugged into a tape transport, and the program recorded in the module. The operator simply turns the keyswitch to the MDL (Module) position and pushes the TO MDL key. An EAROM (Electrically Alterable Read Only Memory) within the module records the program without disturbing the program in the programmer memory. Then, rather than reprogram the LN1300 Process Programmer step-by-step when the same program is called for later, all the user needs to do is plug in the module, turn the switch and press the FROM MDL key. It takes just seconds to have a stored program transferred to the Programmer, or a program copied on the module. The module will retain a program for at least a year. Each time the module is used, its EAROM is refreshed for another year.

The ease and simplicity of this technique of program storage makes it an invaluable asset when different processes are to be directed from the same programmer, or modifications to a process are a frequent occurrence. In such applications, a "library" of program modules can save time and eliminate the possibility of programming error.

Dual Program Capability



The dual program capability of the 1300 Process Programmer enables it to simultaneously generate two independent set-point outputs to two different process controllers governing different process variables. In the example above, two variables—pressure and temperature—are plotted in a pattern of soaks and ramps typical of many industrial processes. The program for each of the two outputs is independently entered into the process programmer with its own timed sequence of ramps and soaks. In operation, the two programs begin simultaneously.

An independent program HOLD function is provided for each of the set-point outputs for use with the controller's deviation contacts. This hold function will temporarily stop the program if the processes cannot keep up with the scheduled program. This also guarantees that the timed soak intervals will not start until the desired soak temperature has been reached.

The small bar chart at the bottom of the chart above represents on/off process functions which are almost always needed in a process. The process programmer has a built-in logic capability to handle these needs with logic that greatly reduces the requirement and expense of external hardware.

PROGRAM MODULE
PROGRAM NUMBER
LEEDS & NORTHRUP

Use any range

Establishing the operating ranges for a process with the 1300 Process Programmer is a simple procedure because of the instrument's range entry technique. This technique enables a 1300 Programmer to interface with virtually any standard analog controller. The operator can select any one of seven standard primary elements and enter any range end-points within the operating limits of these primary elements directly from the keyboard on the front panel. The output signal is automatically scaled to the range entered, no matter whether the range is wide or narrow, and regardless which portion of the primary element curve is being used. The Programmer always provides full output resolution (4000 count) for every range—even on narrow ranges.

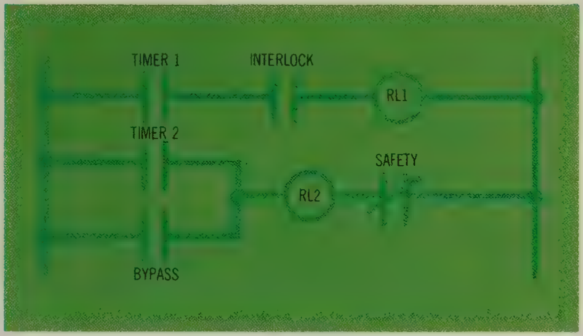
Seven sensor curves

Curves for standard type B, J, K, R, S, T and W5 (W,5%Rh—W,26%Rh) thermocouples are permanently stored in the memory of all 1300 Process Programmers so that all set-point signals can be exactly matched to the primary sensors used by the process controllers. The programmer can also provide a linear set-point signal. Moving a set of internal jumpers is all that is required to establish the characteristics of each set-point output. Optional plug-in modules permit substituting three of the standard sensor curves with curves for three different primary elements, such as resistance thermometers or other thermocouples.

Choice of outputs

To allow the use of any of a wide variety of controllers available today, the 1300 Process Programmer will transmit an output signal of 0 to 5, 0 to 10, 0 to 15, or 1 to 5 volts, or 4 to 20 or 0 to 20 milliamps. Establishing the output signal is a simple matter of plugging in the appropriate output card for each of the two outputs. When the controller range limits are entered into the Process Programmer in engineering units, the lower and upper limits of the output are automatically scaled to the lower and upper limits of the controller being used.

Programmable Logic... without external hardware



The logic capability of the 1300 Process Programmer gives it added utility and flexibility when compared with other set-point programmers. No timers or interrupters are needed to achieve a variety of time-related events in the program. When alternate event sequences are required, there's usually no need to rewire relay cabinets and reorder new parts or equipment. A simple re-editing of the program is often all that is needed. Substantial savings are realized in engineering time, drawing changes, cost and time required for rewiring and extra equipment costs.

The logic format of the 1300 Programmer is a simple one. First, there are 16 inputs, 3 of which are dedicated to provide remote operation of keyboard functions (Start, Stop and Reset). The remaining thirteen are assignable to any contact closure inputs such as on-off or open-closed conditions of fans, vanes, dampers, doors, valves, levels, conveyors, motors, etc. Next, there are 40 logic events, the equivalent of 40 internal relays. Four of these events are dedicated to hold and recycle functions, and eight may be dedicated to optional logic output relays. The remaining events can be programmed as on-off events or as combinations of events, both on-off and time/temperature related events.

The eight logic outputs are relay contacts activating external solenoids, contactors, relays, and actuators to operate valves, vents, alarms, etc. A choice of electromechanical or solid-state relays is offered.

This combination of keyboard entered set points and logic events offers exceptional versatility in developing a process program. When coupled with the wide range of controllers which can be used with the programmer, its utility as an almost universally applicable process governing tool is readily apparent.

In large, complex and heavy switching processes where a more powerful programmable logic controller is called for, the 1300 Process Programmer provides an excellent means of interfacing the set-point program with the PLC of your choice.

1300 PROCESS PROGRAMMER SPECIFICATIONS

SET-POINT OUTPUT SPECIFICATIONS

Number of Outputs: One or two independent set-point signals.

Types of Outputs: Voltage or current corresponding to remote set-point input requirements for most controllers. For programmers with two outputs, any two of the available output types can be provided.

Voltage Outputs: 0 to 5 Vdc, 0 to 10 Vdc, 0 to 15 Vdc or 1 to 5 Vdc. Standard output for Series 80 Controller (0 to 10 Vdc Adjustable). Minimum load resistance: 400 ohms.

Current Outputs: 0 to 20 mA dc or 4 to 20 mA dc. Maximum compliance voltage 20 Vdc.

Output Resolution: ±0.025% uses 12 bit binary digital-to-analog converter.

Output Accuracy: ±0.1% of full scale at 25°C ±20°C.

Output Characteristics: Output(s) are linear or non-linear to match set-point requirements of controller(s) being used. All 1300 Process Programmers have a built-in capability to provide a non-linear output for any one of seven sensor curves for each setpoint output. Selection is made using jumpers. A jumper is provided to select C° or F° calibration.

Type of Sensor	Range of Operation	Max. Conformity Error
LINEAR:	−3999 to +3999 (counts)	None
NON-LINEAR: Type B Thermocouple (Platinum, 30% Rhodium-Platinum, 6% Rhodium)	+120° to +3300°F +48° to +1815°C	0.5°F 0.28°C
Type J Thermocouple (Iron-Constantan)	−350° to +2190°F −212° to +1200°C	0.5°F 0.28°C
Type K Thermocouple (Nickel, Chromium-Nickel, Aluminum)	−390° to +2500°F −234° to +1371°C	0.5°F 0.28°C
Type R Thermocouple (Platinum, 13% Rhodium-Platinum)	−50° to +3210°F −45° to +1765°C	0.5°F 0.28°C
Type S Thermocouple (Platinum, 10% Rhodium-Platinum)	−50° to +3210°F −45° to +1765°C	0.5°F 0.28°C
Type T Thermocouple (Copper-Constantan)	−450° to +750°F −267° to +398°C	0.5°F 0.28°C
Type W5 Thermocouple (Tungsten, 5% Rhenium — Tungsten, 26% Rhenium)	0° to +3980°F −17° to +2193°C	0.5°F 0.28°C

Output Connections: Terminal board on rear of instrument with screw terminals.

Output Programming:

Number of Programs: One or two depending on number of outputs.

Regions Per Program: 16 regions per program; any region may be a soak or a ramp except first region (Region 0) which must be a soak.

Program Time: Regions individually programmable in hours and minutes to a maximum of 99 hours, 59 minutes per region.

Resolution: 1 minute

Accuracy: ±0.1% of setting +2 seconds.

LOGIC FUNCTION SPECIFICATIONS

Logic Inputs: Sixteen (16) optically isolated logic inputs (0 to 15). Inputs require a nominal 10Vdc Logic level for at least 2 seconds. Logic 1: ⩾ +9Vdc; Logic 0: ⩽ 1Vdc; Maximum voltage: 14Vdc; Maximum Reverse Voltage: 28Vdc

Logic Voltage Supply: A 12Vdc power supply is provided in the Programmer which may be connected to user contacts to provide Logic Input signals.

Logic Input Connections: 37-pin D-type connector at rear of instrument. Two pins are used for each logic input and two pins to output internal 12Vdc logic supply.

Dedicated Inputs: Three logic inputs are dedicated to duplicate instrument keyboard functions from a remote pushbutton. These are: INPUT 13: Remote STOP; INPUT 14: Remote RESET PRGM; Input 15: Remote START.

Logic Events: Forty events are provided. The programmable logic control portion of the instrument contains the equivalent of 40 internal relays which are termed "events".

Dedicated Events: Events 0 through 7 inclusive are internally assigned to output relays which may be installed in the instrument.

Event 36: Dedicated to "HOLD" program for set-point Output No. 1 at current value and stop advancement of region time.

Event 37: Dedicated to "HOLD" program for set-point Output No. 2 at current value and stop advancement of region time.

Event 38: Dedicated to "Recycle" Output No. 1 to beginning of program (Region 0) and automatically restart program.

Event 39: Dedicated to "Recycle" Output No. 2 to beginning of program (Region 0) and automatically restart program. NOTE: When a "Recycle" occurs, all Logic Events associated with that output are reset to the "0" state.

Programmed Events: Events 0 to 35 inclusive may be programmed as "Combinational" or "Latched" events.

Combinational Events: Any event may be programmed to be an AND/OR/NOT combination of two other events and/or inputs. Five levels of cascaded events may be programmed.

Latched (ON/OFF) Events: Any event may be programmed to "turn on" in any region of a program at a specific time or at a specific setpoint value in that region. The event may also be programmed to "turn off" in any region of the program at a specific time or setpoint value in that region. Latched events can also be turned on or off as a function of either other events or inputs.

Power Switching Event Outputs: The programmer can be provided with four or eight output relays. The operation of these relays is controlled by the logic program for LOGIC Events 0 through 3 or 0 through 7 respectively.

Relay Selection: Available with one or two relay cards, 4 relays per card.

Electromechanical Contact Ratings

Voltage: 127Vac rms Max. Resistive
30Vdc Max. Resistive
Current: 2 Ampere Max. ac or dc.

D.C. Solid State Ratings
Voltage: 45Vdc Max.
Current: 0.2 Ampere Max.

A.C. Solid State Ratings
Voltage: 264Vac Max.
Current: 0.8 Ampere Max.

Program Capacity:

Internal: Internally stores one dual output program with up to 16 Regions in each output and all associated logic programming. Program is stored in CMOS Memory with 1000 hour battery back-up in the event of power failure.

External: Optional interface available to non-destructively record and store entire internal program on solid state program module using EAROM non-volatile memory.

GENERAL SPECIFICATIONS

Operating Temperature: 0 to +50°C, +32 to +122°F

Storage Temperature: −20 to +80°C, −4 to +176°F

Humidity Limit: 0 to 90% R.H., non-condensing

Power: Standard 120Vac ±10%, 50/60 Hz
Optional 240Vac ±10%, 50/60 Hz

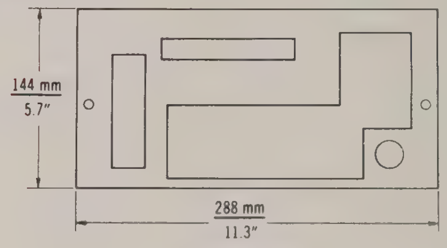
Power Failure Indicator: Back Lighted indicator for "POWER FAILURE".

Power Failure Response: If power is interrupted for less than one second, program proceeds from last point when power is resumed. If power is interrupted for more than one second, "POWER FAILURE" indicator lights up and program is HELD at point in program where power was lost. After power is resumed, the start button will restart the program from the last point.

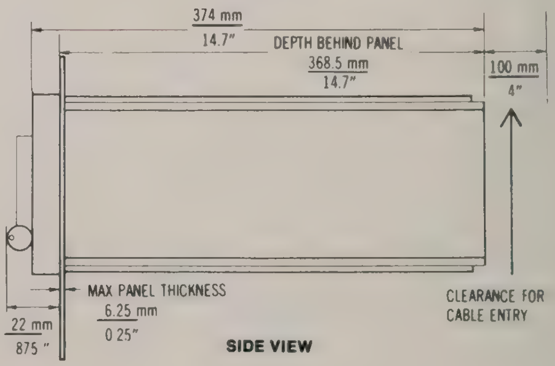
Keyboard: A monoplanar front panel with touch switch keys.

Dimensions: Front panel cut-out: 282mm (11.1") W × 138mm (5.4") H.
Front bezel: 288mm (11.3") W ×144mm (5.7") H.
Depth: 374mm (14.7")

Weight: 10 Kg (22 lbs.)



FRONT VIEW



SIDE VIEW

LEEDS & NORTHRUP
A UNIT OF GENERAL SIGNAL

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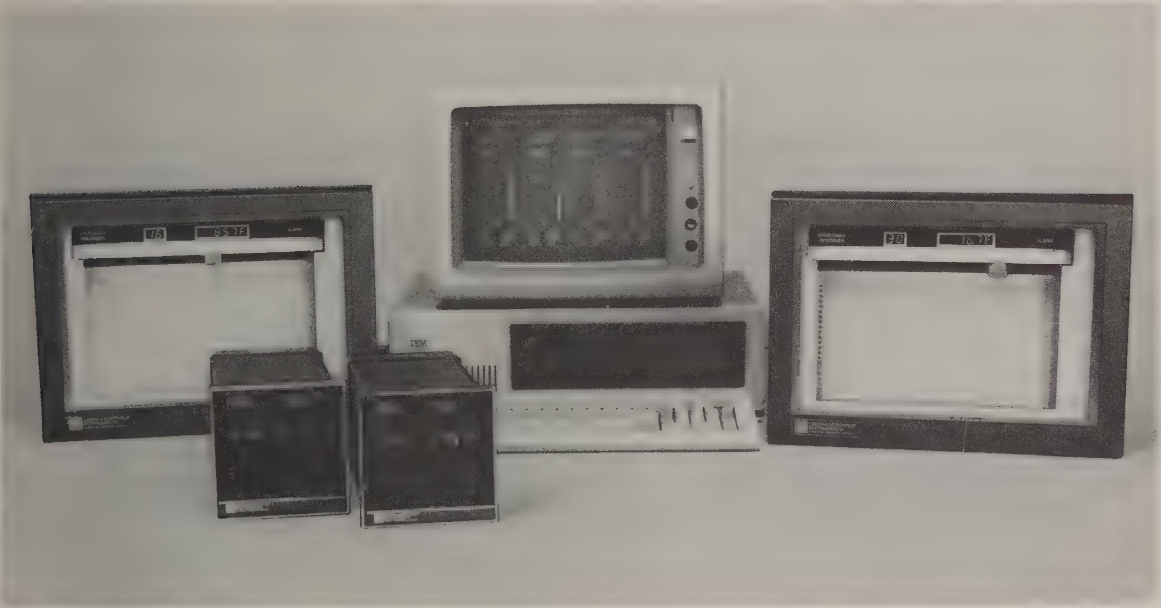
PC-8500 Computer Interface Software for SPEEDOMAX® 1650/2500 Recorders and Electromax® V^{PLUS} Controllers



- **Centralized process interface enables remote operation of up to 30 Speedomax 1650/2500 recorders or up to 60 Electromax V^{PLUS} controllers**
- **Individual recorder point or controller tag names**
- **Central alarm reporting and printout of process upsets**
- **Scheduled printout or computer disk storage of process variables and controller setpoints for documenting process performance**
- **Complete recorder or controller configuration storage and download for rapid controller substitution or process turnaround**
- **Recipe storage and downloading to controllers using user-defined recipe names assures reproducible program cycles**
- **Software provides interfaces for both Speedomax 1650/2500 recorders and all Electromax V^{PLUS} controllers (PID, On/Off, Limit)**
- **Single loop integrity and strip chart records provide maximum process/production security**
- **Runs on industry standard computers—IBM XT, AT, and 5531**
- **Customizing service available for items such as custom report formatting, trending, process optimization, security access, custom recipe entry**

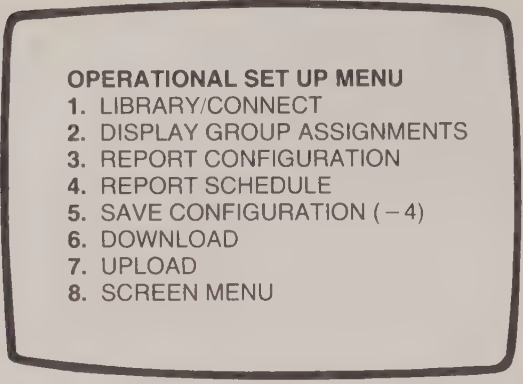
The Leeds & Northrup Computer Interface Software package takes full advantage of the Speedomax 1650/2500 recorder's and Electromax V^{PLUS} controller's Serial Communications Option and the power of the IBM personal computer. The computer serves as the master or supervisor with each recorder or controller a slave supporting the data acquisition or loop control function independently. Up to two multidrop links can support any combination of recorders and controllers up to a maximum of 30 recorders or 60 controllers (30 per link).

The software Application package provides a practical solution for remotely monitoring, operating, downloading, and recording data from multiple controllers and recorders. Use of the software package can serve as a first or continuing step toward automating plant operations.

LEEDS & NORTHRUP
INSTRUMENTS
A UNIT OF GENERAL SIGNAL

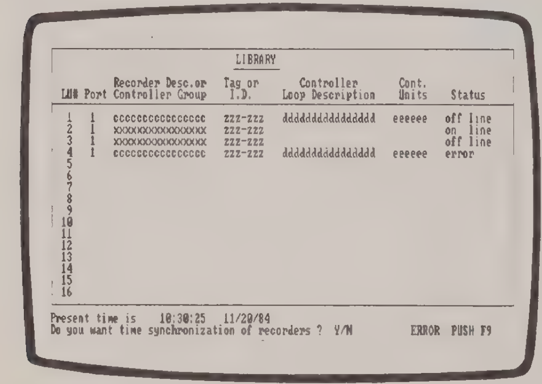
We put you in control.

Operating Functions Via Menu Lists



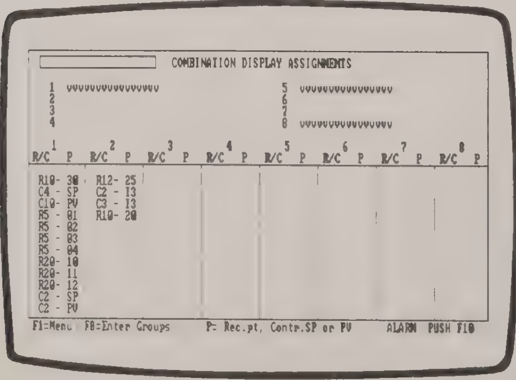
```
OPERATIONAL SET UP MENU
1. LIBRARY/CONNECT
2. DISPLAY GROUP ASSIGNMENTS
3. REPORT CONFIGURATION
4. REPORT SCHEDULE
5. SAVE CONFIGURATION (-4)
6. DOWNLOAD
7. UPLOAD
8. SCREEN MENU
```

Operational Set Up Menu—The recorder and controller On-line and Off-line status, display group assignments, report configurations and report schedule may be stored on computer disk using the Save Configuration selection. These preconfigured selections will then be automatically executed upon process selection when entering the RUN program.



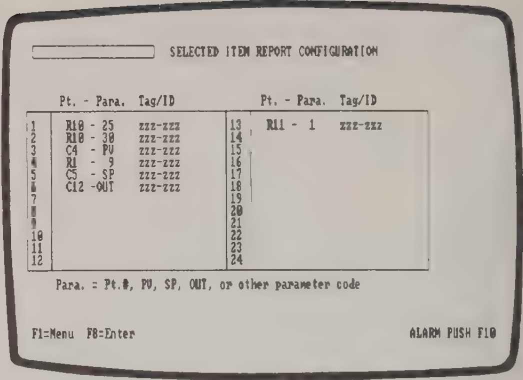
```
                              LIBRARY

          Recorder Desc.or    Tag or      Controller       Cont.
 LU# Port Controller Group     I.D.    Loop Description    Units     Status

  1   1   cccccccccccccccc   zzz-zzz   dddddddddddddddd   eeeeee   off line
  2   1   xxxxxxxxxxxxxxxx   zzz-zzz                               on  line
  3   1   xxxxxxxxxxxxxxxx   zzz-zzz                               off line
  4   1   cccccccccccccccc   zzz-zzz   dddddddddddddddd   eeeeee   error
  5
  6
  7
  8
  9
 10
 11
 12
 13
 14
 15
 16

Present time is    10:30:25   11/20/84
Do you want time synchronization of recorders ?  Y/N          ERROR  PUSH F9
```

Library/Connect Screen—Provides a list of all recorders and controllers defined in the Process Definition file, including group identification, tag names, loop descriptions and units of measure. The On-line or Off-line status of each unit may be viewed or altered and time synchronization of all recorder clocks may be performed using simple keyboard entry.



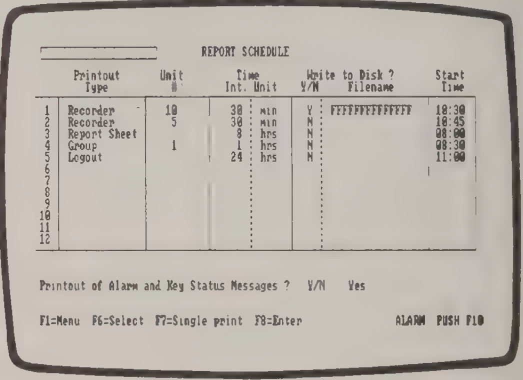
```
                 COMBINATION DISPLAY ASSIGNMENTS

  1  vvvvvvvvvvvvvvvv                    5  vvvvvvvvvvvvvvvv
  2                                      6
  3                                      7
  4                                      8  vvvvvvvvvvvvvvvv

   1       2       3       4       5       6       7       8
R/C  P  R/C  P  R/C  P  R/C  P  R/C  P  R/C  P  R/C  P  R/C  P

R10- 30 R12- 25
C4 - SP C2 - I3
C10- PV C3 - I3
R5 - 01 R10- 20
R5 - 02
R5 - 03
R5 - 04
R20- 10
R20- 11
R20- 12
C2 - SP
C2 - PV
F1=Menu  F8=Enter Groups     P= Rec.pt, Contr.SP or PV     ALARM  PUSH F10
```

Combination Display Assignment Screen—This data entry screen permits grouping recorder points and controller process variables or setpoints into a common display group. A maximum of 12 parameters may be combined for viewing on the Combination Group and Bar Graph displays, for printing or for storage on computer disk. A maximum of 8 groups may be identified.



```
                SELECTED ITEM REPORT CONFIGURATION

   Pt. - Para.  Tag/ID              Pt. - Para.  Tag/ID

 1   R10 - 25   zzz-zzz        13   R11 -  1   zzz-zzz
 2   R10 - 30   zzz-zzz        14
 3   C4  - PV   zzz-zzz        15
 4   R1  -  9   zzz-zzz        16
 5   C5  - SP   zzz-zzz        17
 6   C12 -OUT   zzz-zzz        18
 7                             19
 8                             20
 9                             21
10                             22
11                             23
12                             24
   Para. = Pt.#, PV, SP, OUT, or other parameter code

F1=Menu  F8=Enter                                   ALARM PUSH F10
```

Report Configuration Screen—The Report Configuration entry screen permits assigning up to 24 parameters from any controller, or measured variable from any recorder on either of two links for printing or disk storage. The variables entered in this configuration may be viewed on the Report display in the RUN program. The update rate for this data is selected using the Report Schedule Entry Screen.

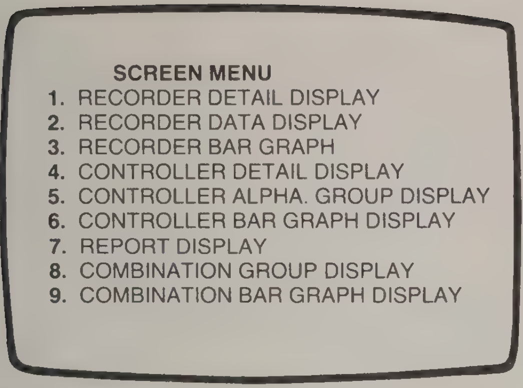


```
                           REPORT SCHEDULE

      Printout       Unit       Time       Write to Disk ?       Start
        Type          #       Int. Unit   Y/N    Filename        Time

 1  Recorder          10       30 : min    Y : FFFFFFFFFFFFFF    10:30
 2  Recorder           5       30 : min    N :                   10:45
 3  Report Sheet                8 : hrs    N :                   08:00
 4  Group              1        1 : hrs    N :                   08:30
 5  Logout                     24 : hrs    N :                   11:00
 6                                :          :
 7                                :          :
 8                                :          :
 9                                :          :
10                                :          :
11                                :          :
12                                :          :

Printout of Alarm and Key Status Messages ?  Y/N   Yes

F1=Menu  F6=Select  F7=Single print  F8=Enter             ALARM  PUSH F10
```

Report Schedule Screen—A data entry screen for scheduling reports going to a printer or storage on computer disk. Files may include Recorder Data screens, Combination Display screens, a Report screen, or a log of all recorder points. If data is stored on disk, user file names identify each file. The update rate and starting time for each file may be independently set in minutes or hours. The printout of alarm messages is determined by a selection on this screen.

Download—Permits user to download either recorder or controller configurations or controller recipes stored on floppy or fixed disk preconfigured for a single controller, controller group, or all controllers.

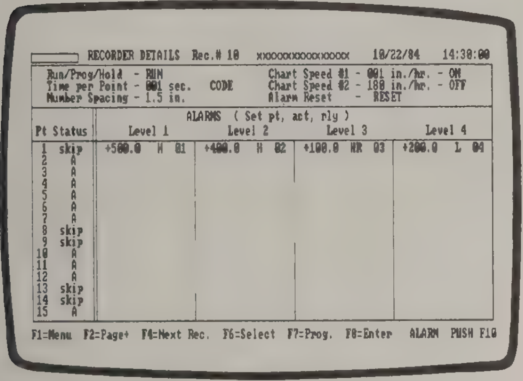
Upload—Permits user to upload a complete recorder or controller configuration or a recipe for a selected controller, controller group, or all controllers to a designated file. Uploaded recorder configuration files may not be altered.



```
SCREEN MENU
1. RECORDER DETAIL DISPLAY
2. RECORDER DATA DISPLAY
3. RECORDER BAR GRAPH
4. CONTROLLER DETAIL DISPLAY
5. CONTROLLER ALPHA. GROUP DISPLAY
6. CONTROLLER BAR GRAPH DISPLAY
7. REPORT DISPLAY
8. COMBINATION GROUP DISPLAY
9. COMBINATION BAR GRAPH DISPLAY
```

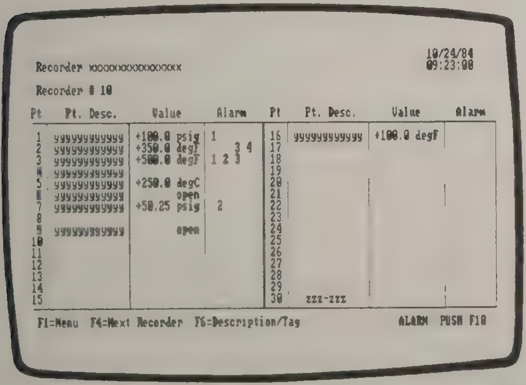
Screen Menu—Selects screen menu list.

Screen Menu (On-Line Displays)



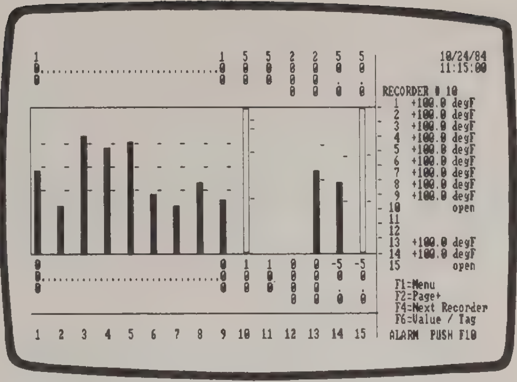
```
     RECORDER DETAILS  Rec.# 10   xxxxxxxxxxxxxxxx   10/22/84   14:30:00
 Run/Prog/Hold  - RUN                     Chart Speed #1 - 001 in./hr. - ON
 Time per Point - 001 sec.   CODE         Chart Speed #2 - 180 in./hr. - OFF
 Number Spacing - 1.5 in.                 Alarm Reset    -  RESET
                        ALARMS  ( Set pt, act, rly )
Pt Status     Level 1         Level 2         Level 3         Level 4
 1  skip   +500.0  H  01   +400.0  H  02   +100.0  HR  03   +200.0  L  04
 2     A
 3     A
 4     A
 5     A
 6     A
 7     A
 8  skip
 9  skip
10     A
11     A
12     A
13  skip
14  skip
15     A
F1=Menu  F2=Page+  F4=Next Rec.  F6=Select  F7=Prog.  F8=Enter   ALARM  PUSH F10
```

Recorder Detail Display—Provided for each recorder and accessed by recorder number, this screen permits the user to alter recorder parameters from the keyboard. The user may change asterisked (*) parameters including recorder run/program/hold status, point skip status, alarm set points, chart speeds etc. A code number is available for security on recorder data.



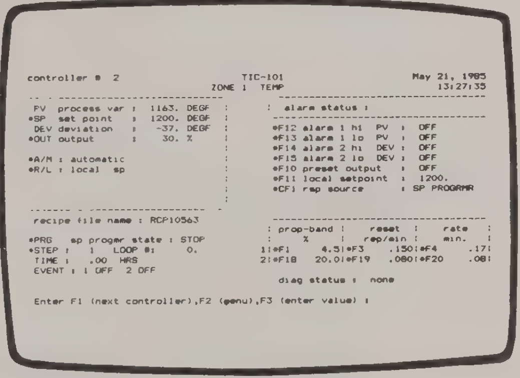
```
Recorder xxxxxxxxxxxxxxxx                                            10/24/84
                                                                     09:23:00
Recorder # 10
Pt  Pt. Desc.      Value        Alarm    Pt   Pt. Desc.      Value        Alarm
 1  yyyyyyyyyyyy  +100.0 psig   1        16   yyyyyyyyyyyy  +100.0 degF
 2  yyyyyyyyyyyy  +350.0 degF       3 4  17
 3  yyyyyyyyyyyy  +500.0 degF   1 2 3    18
 4  yyyyyyyyyyyy                         19
 5  yyyyyyyyyyyy  +250.0 degC            20
 6  yyyyyyyyyyyy         open            21
 7  yyyyyyyyyyyy  +50.25 psig    2       22
 8                                       23
 9  yyyyyyyyyyyy         open            24
10                                       25
11                                       26
12                                       27
13                                       28
14                                       29
15                                       30     zzz-zzz
F1=Menu  F4=Next Recorder  F6=Description/Tag                     ALARM  PUSH F10
```

Recorder Data Display—Provides current variable information and alarm status for all points on a single recorder. Active alarm levels are indicated with a red level number. Point description and point tag names share a common display area and alternate by depressing a dedicated key.



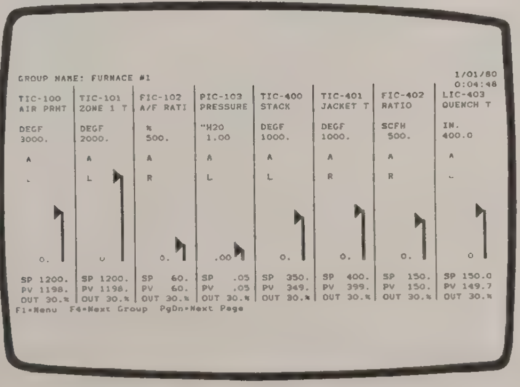
```
                                     10/24/84
                                     11:15:00
                               RECORDER # 10
                                1  +100.0 degF
                                2  +100.0 degF
                                3  +100.0 degF
                                4  +100.0 degF
                                5  +100.0 degF
                                6  +100.0 degF
                                7  +100.0 degF
                                8  +100.0 degF
                                9  +100.0 degF
                               10         open
                               11
                               12
                               13  +100.0 degF
                               14  +100.0 degF
                               15         open
                                F1=Menu
                                F2=Page+
                                F4=Next Recorder
                                F6=Value / Tag
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15   ALARM  PUSH F10
```

Recorder Bar Graph Display—Bar graph indication for 15 points from a single recorder is provided. A second screen, selectable by single key, is available for recorders with more than 15 points.



```
controller #  2                    TIC-101                     May 21, 1985
                               ZONE 1  TEMP                        13:27:35
 PV  process var :  1163. DEGF  :      : alarm status :
*SP  set point   :  1200. DEGF  :
 DEV deviation   :   -37. DEGF  :      *F12 alarm 1 hi  PV  :  OFF
*OUT output      :    30. %     :      *F13 alarm 1 lo  PV  :  OFF
                                :      *F14 alarm 2 hi  DEV :  OFF
*A/M : automatic                :      *F15 alarm 2 lo  DEV :  OFF
*R/L : local  sp                :      *F10 preset output   :  OFF
                                :      *F11 local setpoint  :  1200.
                                :      *CF1 rmp source      : SP PROGRMR
 recipe file name : RCP10563
                                      : prop-band :   reset  :   rate   :
*PRG   sp progmr state : STOP         :     %     :  rep/min :   min.   :
*STEP :   1   LOOP #:    0.          1:*F1    4.5:*F3   .150:*F4    .17:
 TIME :   .00  HRS                   2:*F18  20.0:*F19  .080:*F20   .08:
 EVENT : 1 OFF  2 OFF
                                        diag status :  none
 Enter F1 (next controller),F2 (menu),F3 (enter value) :
```

Controller Detail Display—Provided for each controller and accessed by controller number. This screen permits the user to alter controller parameters from the keyboard; user may change asterisked (*) parameters including setpoint, alarm values, tuning constants, etc. plus setpoint programmer start/stop, reset, step selection and self-tune hold-off/on. Ratio and bias are also alterable for ratio control. Parameters for options not in a controller are not displayed.

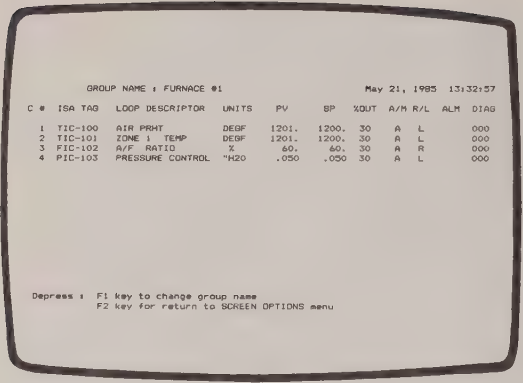


```
GROUP NAME: FURNACE #1                                                       1/01/80
                                                                             0:04:48
TIC-100  | TIC-101  | FIC-102  | PIC-103  | TIC-400  | TIC-401  | FIC-402  | LIC-403
AIR PRHT | ZONE 1 T | A/F RATI | PRESSURE | STACK    | JACKET T | RATIO    | QUENCH T

DEGF     | DEGF     | %        | "H20     | DEGF     | DEGF     | SCFH     | IN.
3000.    | 2000.    | 500.     |  1.00    | 1000.    | 1000.    |  500.    | 400.0

A        | A        | A        | A        | A        | A        | A        | A
L        | L        | R        | L        | L        | R        | R        | L

   0.    |    0     |   0.     |  .00     |   0.     |   0.     |   0.     |   0

SP 1200. | SP 1200. | SP   60. | SP   .05 | SP  350. | SP  400. | SP  150. | SP 150.0
PV 1198. | PV 1198. | PV   60. | PV   .05 | PV  349. | PV  399. | PV  150. | PV 149.7
OUT 30.% | OUT 30.% | OUT 30.% | OUT 30.% | OUT 30.% | OUT 30.% | OUT 30.% | OUT 30.%
F1=Menu  F4=Next Group  PgDn=Next Page
```

Controller Bar Graph Display—Provides a bar representation of a controller group for monitoring, displayed in groups of eight on each screen.

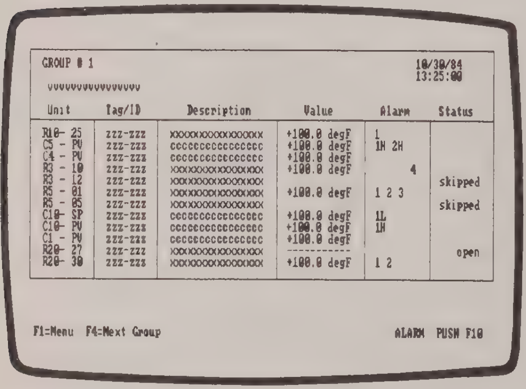
Max. No. of controllers in a group—16

Max. No. of screen pages per group—2



```
          GROUP NAME : FURNACE #1                      May 21, 1985  13:32:57

C #  ISA TAG   LOOP DESCRIPTOR   UNITS    PV      SP    %OUT  A/M R/L  ALM  DIAG

  1  TIC-100   AIR PRHT          DEGF    1201.   1200.   30    A   L         000
  2  TIC-101   ZONE 1  TEMP      DEGF    1201.   1200.   30    A   L         000
  3  FIC-102   A/F  RATIO         %        60.     60.   30    A   R         000
  4  PIC-103   PRESSURE CONTROL  "H20     .050    .050   30    A   L         000




Depress :  F1 key to change group name
           F2 key for return to SCREEN OPTIONS menu
```

Controller Alpha. Group Display—Provides same information as controller bar graph display but in alphanumeric format. Displays all controllers in a group (up to 16); monitor only.

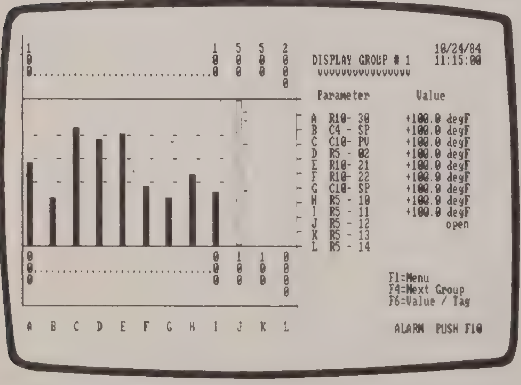


```
GROUP # 1                                                      10/30/84
                                                               13:25:00
 vvvvvvvvvvvvvvvv

 Unit     Tag/ID       Description          Value         Alarm    Status

R10- 25   zzz-zzz   xxxxxxxxxxxxxxxx   +100.0 degF    1
C5 - PV   zzz-zzz   cccccccccccccccc   +100.0 degF    1H 2H
C4 - PV   zzz-zzz   cccccccccccccccc   +100.0 degF
R3 - 10   zzz-zzz   xxxxxxxxxxxxxxxx   +100.0 degF          4
R3 - 12   zzz-zzz   xxxxxxxxxxxxxxxx                               skipped
R5 - 01   zzz-zzz   xxxxxxxxxxxxxxxx   +100.0 degF    1 2 3
R5 - 05   zzz-zzz   xxxxxxxxxxxxxxxx                               skipped
C10- SP   zzz-zzz   cccccccccccccccc   +100.0 degF    1L
C10- PV   zzz-zzz   cccccccccccccccc   +100.0 degF    1H
C1 - PV   zzz-zzz   cccccccccccccccc   +100.0 degF
R20- 27   zzz-zzz   xxxxxxxxxxxxxxxx   -----------                    open
R20- 30   zzz-zzz   xxxxxxxxxxxxxxxx   +100.0 degF    1 2


F1=Menu  F4=Next Group                                        ALARM  PUSH F10
```

Combination Group Display—Provides current process variable and alarm indication for selected recorder points and controllers on the link.

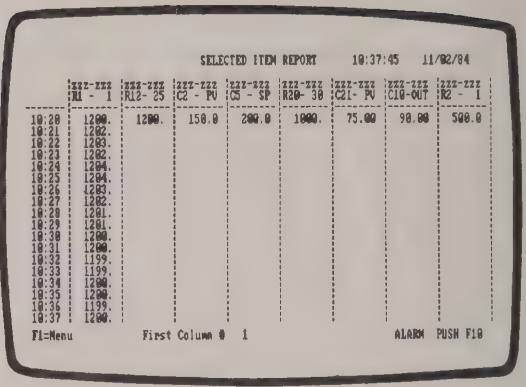
Max. No. of Parameters—12

Max. No. of Groups—8



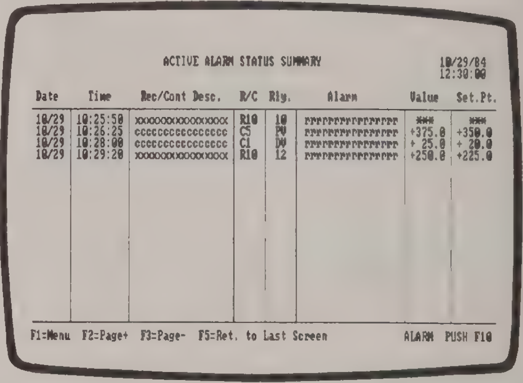
```
DISPLAY GROUP # 1      10/24/84
 vvvvvvvvvvvvvvvv      11:15:00

 Parameter          Value

A  R10- 30      +100.0 degF
B  C4 - SP      +100.0 degF
C  C10- PV      +100.0 degF
D  R5 - 02      +100.0 degF
E  R10- 21      +100.0 degF
F  R10- 22      +100.0 degF
G  C10- SP      +100.0 degF
H  R5 - 10      +100.0 degF
I  R5 - 11      +100.0 degF
J  R5 - 12             open
K  R5 - 13
L  R5 - 14

                F1=Menu
                F4=Next Group
                F6=Value / Tag

                 ALARM  PUSH F10
```

Combination Bar Graph Display—Provides the same information as the Combination Group Display but in bar graph format.



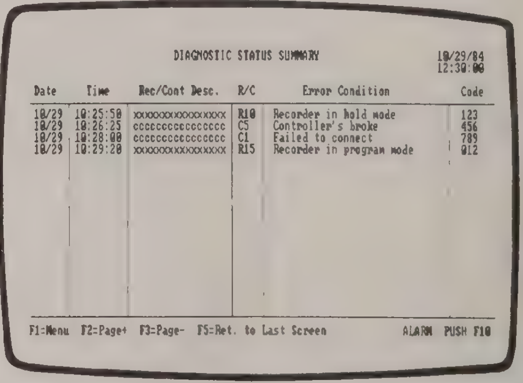
```
                        SELECTED ITEM REPORT      10:37:45    11/02/84

       |zzz-zzz |zzz-zzz |zzz-zzz |zzz-zzz |zzz-zzz |zzz-zzz |zzz-zzz |zzz-zzz |
       |R1 -  1 |R12- 25 |C2 - PV |C5 - SP |R20- 30 |C21- PV |C10-OUT |R2 -  1 |
-------|--------|--------|--------|--------|--------|--------|--------|--------|
 10:20 |  1200. |  1200. |  150.0 |  200.0 |  1000. |  75.00 |  90.00 |  500.0 |
 10:21 |  1202. |        |        |        |        |        |        |        |
 10:22 |  1203. |        |        |        |        |        |        |        |
 10:23 |  1202. |        |        |        |        |        |        |        |
 10:24 |  1204. |        |        |        |        |        |        |        |
 10:25 |  1204. |        |        |        |        |        |        |        |
 10:26 |  1203. |        |        |        |        |        |        |        |
 10:27 |  1202. |        |        |        |        |        |        |        |
 10:28 |  1201. |        |        |        |        |        |        |        |
 10:29 |  1201. |        |        |        |        |        |        |        |
 10:30 |  1200. |        |        |        |        |        |        |        |
 10:31 |  1200. |        |        |        |        |        |        |        |
 10:32 |  1199. |        |        |        |        |        |        |        |
 10:33 |  1199. |        |        |        |        |        |        |        |
 10:34 |  1200. |        |        |        |        |        |        |        |
 10:35 |  1200. |        |        |        |        |        |        |        |
 10:36 |  1199. |        |        |        |        |        |        |        |
 10:37 |  1200. |        |        |        |        |        |        |        |
F1=Menu            First Column #   1                          ALARM  PUSH F10
```

Report Display—Displays a periodic log of parameters from selected controllers or recorder points per the Report Configuration entry. Maximum of 17 readings displayed. The same information can be routed to a printer or computer disk for each new update. While only 6 columns are displayed, user may tab across screen to view any 6 consecutive columns within a range of 24.



```
                    ACTIVE ALARM STATUS SUMMARY                   10/29/84
                                                                  12:30:00
Date    Time     Rec/Cont Desc.    R/C  Rly.       Alarm         Value   Set.Pt.

10/29  10:25:50  xxxxxxxxxxxxxxxx  R10   10   rrrrrrrrrrrrrrrr    ***      ***
10/29  10:26:25  cccccccccccccccc  C5    PV   rrrrrrrrrrrrrrrr  +375.0  +350.0
10/29  10:28:00  cccccccccccccccc  C1    DV   rrrrrrrrrrrrrrrr  + 25.0  + 20.0
10/29  10:29:20  xxxxxxxxxxxxxxxx  R10   12   rrrrrrrrrrrrrrrr  +250.0  +225.0


F1=Menu  F2=Page+  F3=Page-  F5=Ret. to Last Screen           ALARM  PUSH F10
```

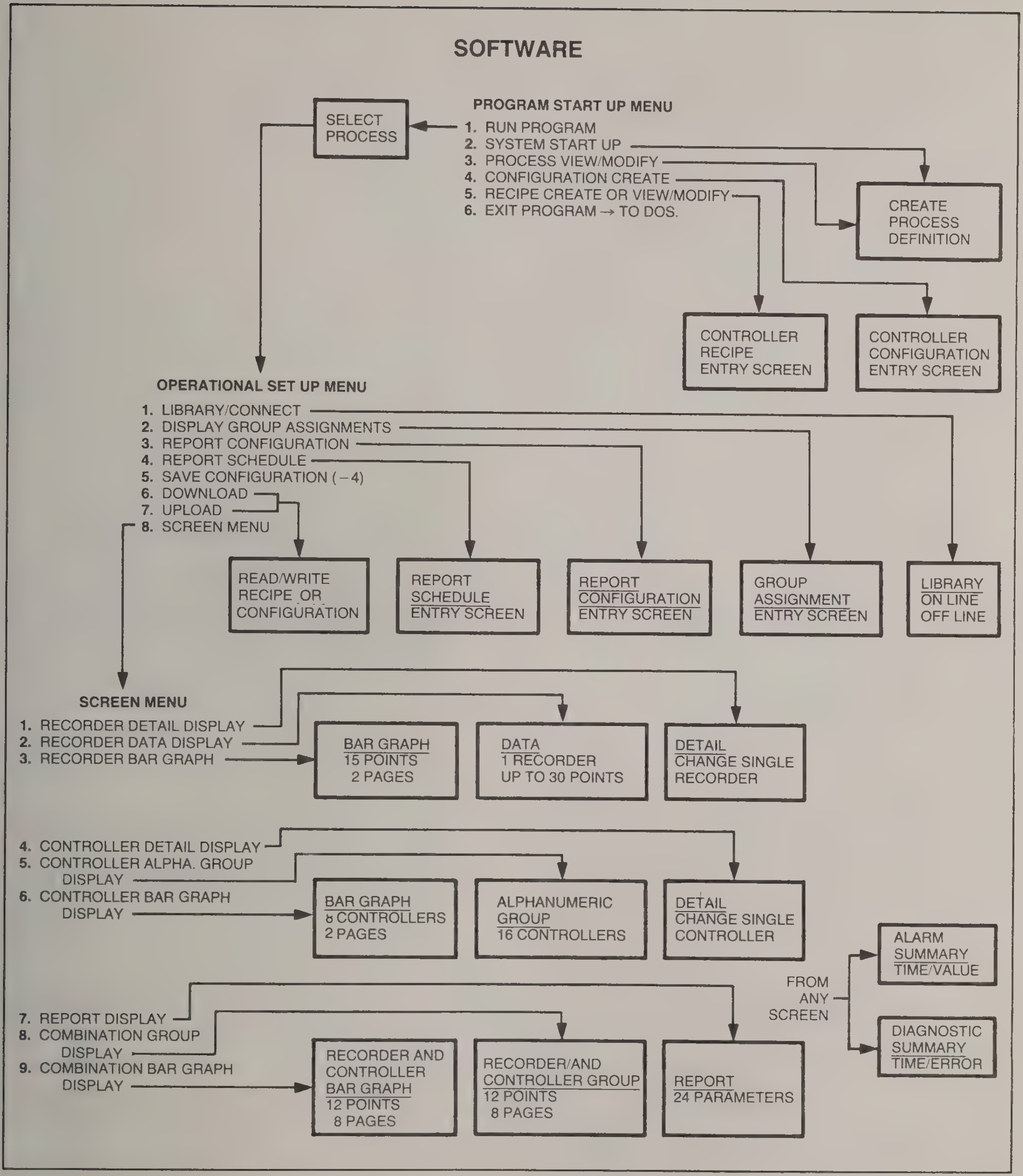
Active Alarm Summary—Displays all active recorder or controller alarms including time of occurrence (to nearest 30 seconds).



```
                    DIAGNOSTIC STATUS SUMMARY                     10/29/84
                                                                  12:30:00
Date    Time     Rec/Cont Desc.    R/C        Error Condition           Code

10/29  10:25:50  xxxxxxxxxxxxxxxx  R10  Recorder in hold mode            123
10/29  10:26:25  cccccccccccccccc  C5   Controller's broke               456
10/29  10:28:00  cccccccccccccccc  C1   Failed to connect                789
10/29  10:29:20  xxxxxxxxxxxxxxxx  R15  Recorder in program mode         012


F1=Menu  F2=Page+  F3=Page-  F5=Ret. to Last Screen           ALARM  PUSH F10
```

Active Diagnostic Summary—Displays all recorder, controller or communication diagnostic errors including time of occurrence, unit identification and error type.

Alarm Scan—All recorders and controllers are scanned for alarms every 30 seconds as a scheduled priority task. A flashing "ALARM PUSH F10" message on any active


SOFTWARE
SELECT PROCESS
PROGRAM START UP MENU
1. RUN PROGRAM
2. SYSTEM START UP
3. PROCESS VIEW/MODIFY
4. CONFIGURATION CREATE
5. RECIPE CREATE OR VIEW/MODIFY
6. EXIT PROGRAM → TO DOS.
CREATE PROCESS DEFINITION
CONTROLLER RECIPE ENTRY SCREEN
CONTROLLER CONFIGURATION ENTRY SCREEN
OPERATIONAL SET UP MENU
1. LIBRARY/CONNECT
2. DISPLAY GROUP ASSIGNMENTS
3. REPORT CONFIGURATION
4. REPORT SCHEDULE
5. SAVE CONFIGURATION (–4)
6. DOWNLOAD
7. UPLOAD
8. SCREEN MENU
READ/WRITE RECIPE OR CONFIGURATION
REPORT SCHEDULE ENTRY SCREEN
REPORT CONFIGURATION ENTRY SCREEN
GROUP ASSIGNMENT ENTRY SCREEN
LIBRARY ON LINE OFF LINE
SCREEN MENU
1. RECORDER DETAIL DISPLAY
2. RECORDER DATA DISPLAY
3. RECORDER BAR GRAPH
BAR GRAPH 15 POINTS 2 PAGES
DATA 1 RECORDER UP TO 30 POINTS
DETAIL CHANGE SINGLE RECORDER
4. CONTROLLER DETAIL DISPLAY
5. CONTROLLER ALPHA. GROUP DISPLAY
6. CONTROLLER BAR GRAPH DISPLAY
BAR GRAPH 8 CONTROLLERS 2 PAGES
ALPHANUMERIC GROUP 16 CONTROLLERS
DETAIL CHANGE SINGLE CONTROLLER
7. REPORT DISPLAY
8. COMBINATION GROUP DISPLAY
9. COMBINATION BAR GRAPH DISPLAY
RECORDER AND CONTROLLER BAR GRAPH 12 POINTS 8 PAGES
RECORDER/AND CONTROLLER GROUP 12 POINTS 8 PAGES
REPORT 24 PARAMETERS
FROM ANY SCREEN
ALARM SUMMARY TIME/VALUE
DIAGNOSTIC SUMMARY TIME/ERROR

APPLICATION SOFTWARE PACKAGE DESCRIPTION

This easy to use program makes available both operating and utility program functions. Utility programs are used to create or modify recipes and configurations and to describe the recorders and controllers with labels used by the operating application program. The operating program provides the operator color video screens and maintains continuous interactive communication between the host computer and all Speedomax 1650/2500 recorders and Electromax V^{PLUS} controllers connected on the link.

After definition files are created using the utility entry screens, operation begins when process definition is selected and the computer is "connected" (via software) to each recorder and controller. The user may then select operations from the Operational Set Up Menu or screen displays from the Screen Menu for recorder or controller supervision.

display indicates presence of a new alarm. Acknowledgement is by accessing the Active Alarm Summary by depressing special function key F10, which causes the alarm message to stop flashing. Only recorder alarms which cause relay action appear on the Active Alarm Summary; alarm levels are not logged.

Alarm Printout—Alarms are printed when first detected and on alarm clear. Only recorder alarms causing relay action are printed; alarm levels are not printed.

Utility Programs

Utility programs are used to create process definition files for recorders and controllers, define controller configuration parameters, and create and assign recipe data files. Entry employs a cursor controlled entry screen for each file. The files created by these utilities are described as follows. Only the Process Definition file is essential for the operating program.

Process Definition File

Created for each recorder or controller, these files provide the unit definitions. Entries include:

a. Recorder or controller unit number, port number, type, physical address.
b. Recorder alarms or controller options present.
c. Tag number (ISA tag).
d. Recorder or loop descriptor—16 characters.
e. Units of measure (per point on recorders).
f. Group name (controllers only).
g. Point description and tag name (recorders only).
h. Alarm descriptors
i. Bar graph scaling—engineering unit scaling of bar graph display limits (controllers only).

Controller Configuration File

Allows the user to define complete controller configurations (F,C,CF functions) which may include range, tuning, scaling, remote setpoint source, control action options, bias arrangements, etc. for Download. Configuration definition files may be created for a single controller, a group of controllers or all controllers. Recorder configuration files may only be created from upload.

Recipe Definition Files (Controllers Only)

Allows the user to create and store recipes identified by unique product names for download. Recipe files include local setpoint, computer setpoint, alarm values and primary tuning parameters. If optional setpoint programming is present in the Electromax V^{PLUS}, the 10 segment program with setpoint guarantees and events is also included. Recipe definition files can be created and downloaded to a single controller, a group of controllers or all controllers. A single recipe may also be downloaded to multiple controllers or controller groups.

Driver Software

The communications driver software consists of a library of subroutines or tasks to enable the programmer to write a specific application program in FORTRAN. All communications and protocol handling is transparent to the user when using the driver "call" statements. Driver software is provided for IBM personal computer hardware. All front panel display and user-programmed parameters (F, CF, C) are accessible enabling full control over multiple Electromax V^{PLUS} controllers or Speedomax recorders.

IBM Package includes:

a) Driver software—module library
b) Application software program and support programs
c) Training software program
d) Documentation for driver and application program software
e) License for one computer.

Compatible Computers

- IBM XT, 5531 or AT
- Operating System—DOS 2.0, 2.1, 3.0
- Number of Async ports supported—2 (COM1 and COM2)
- Number of controllers supported—30 per port (60 max). Number of recorders supported—30 max.
- Required hardware:
  System unit with 640K memory
  IBM Enhanced/Graphics Adapter Board
  IBM Asynchronous Adapter (per port), Serial/Parallel Adapter (AT)
  IBM Color Monitor—medium resolution
  Printer Adapter board plus EPSON-compatible printer
  RS-232-C to RS-422 Interface Adapter (L&N Part No. 063979)

Link Specifications:

Type of network supported: Multidrop, master/slave, RS-422/485 (requires RS-232-C to RS-422 converter for computer RS-232 port).

Baud rates: 300, 1200, 9600

Maximum distance per link: 1000 ft.

Cable: Two twisted shielded pairs, Belden 8723 or 8728 recommended.

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INSTRUMENTS North Wales, Pa 19454
A UNIT OF GENERAL SIGNAL

We put you in control.

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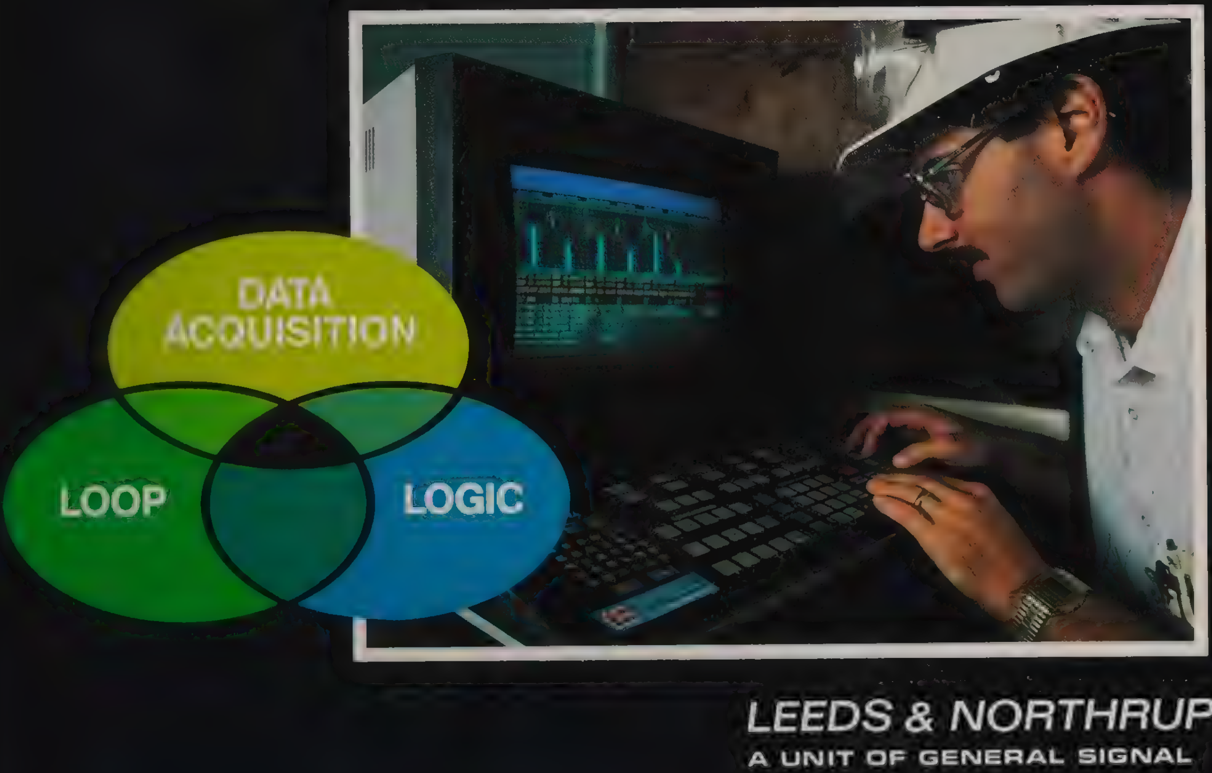
For tighter control and faster, more accurate data

MICROMAX®

Process Management System


DATA ACQUISITION
LOOP
LOGIC

LEEDS & NORTHRUP
A UNIT OF GENERAL SIGNAL

Conventional control schemes for industrial processes are segmented by tasks, with these tasks assigned to individual pieces of equipment. Recorders measure and display process data. Loop controllers regulate variables such as temperature, flow and pressure. Programmable logic controllers both initiate and respond to process events, tripping relays, timing out sequences, etc. Each is concerned with just one aspect of the automation of a process. But since they do affect each other, there must also be interfaces to coordinate their activities. And if centralized supervision or direction is a requirement, a computer has to be added to the automation package.

Such configurations can and do maintain control over a process—after a fashion. They are hardly optimum solutions. Fitting together different hardware and software components inevitably means compromise. Working with several suppliers presents its own set of problems. Not to mention training operator personnel. Or stocking parts. And, with all the interfaces that are needed, it can get to be a fairly expensive proposition. Yet, despite its drawbacks, this is the way you've had to go. Efficient or not. Expensive or not.

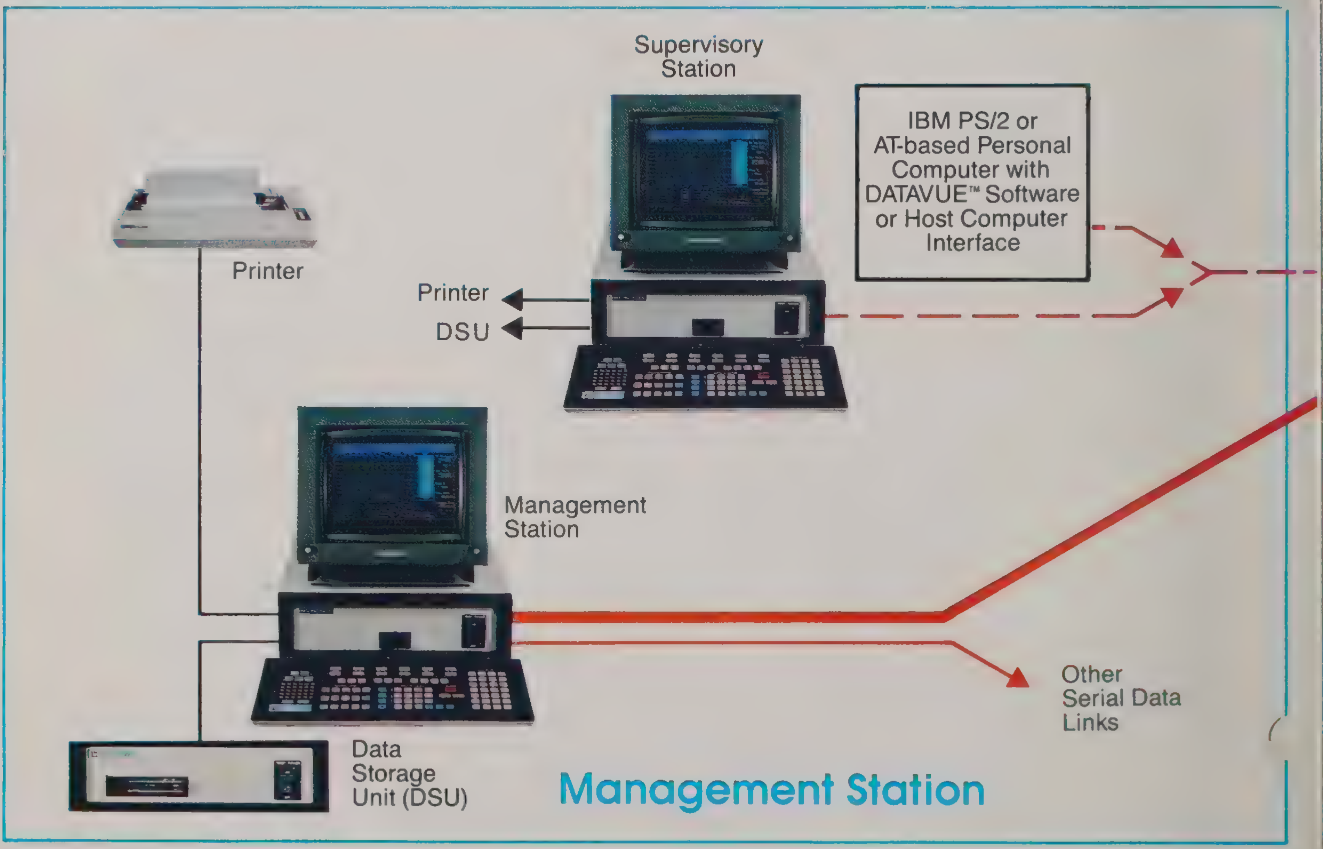
Until now.

A new and better idea

It's called the MICROMAX Process Management System and it's our approach to achieve total control over a process. Not simply a spinoff or extension of anything else we offer, the MICROMAX project began with a clean sheet of paper. A totally new concept in process management, the MICROMAX Process Management System is suitable for both batch and continuous processes. It consolidates all the various operating requirements of a process into a single package, integrating data acquisition together with control execution, including both loop and logic functions. The result is a powerful tool for improving productivity, regardless of the application.

The synergistic effect of this integration of tasks in the MICROMAX control scheme provides significant economic and performance advantages over other control techniques. The continuous interaction of functions makes possible a degree of control over the process which simply cannot be attained using individual instruments dedicated to specific tasks. And since the MICROMAX Process Management System can be closely sized to each application, it's affordable for virtually any process, small or large, simple or complex.

Typical MICROMAX Process Management System



What is it?

Basically, a MICROMAX Process Management System is composed of a Management Station and one or more Field Stations, with the primary component of each Field Station being a Local Processing Unit. MICROMAX can be configured into:

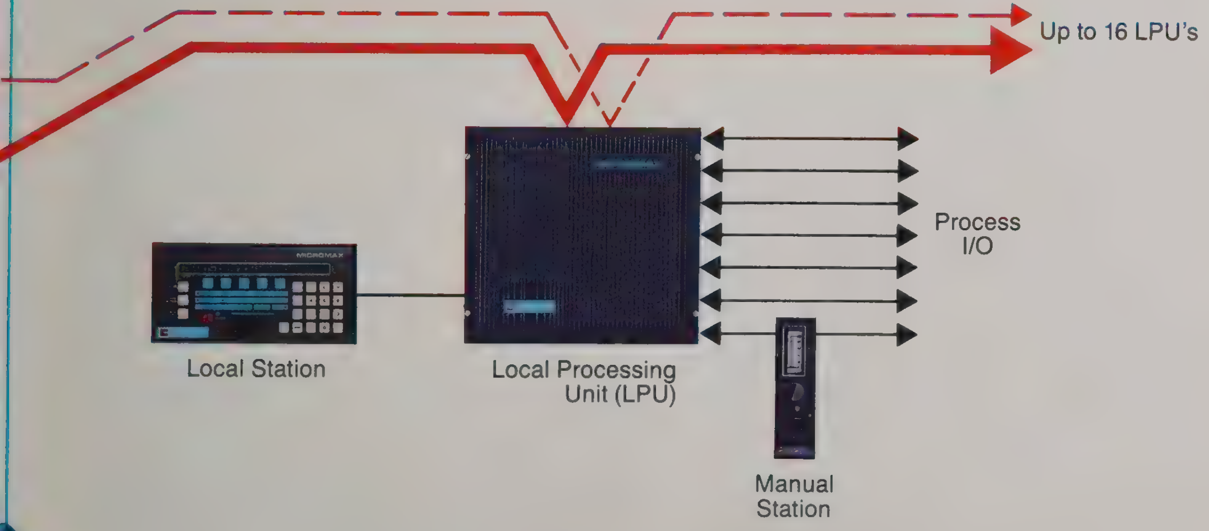
1) a powerful data acquisition system, or
2) a totally integrated process management system including data acquisition, loop control and logic control.

The centrally located Management Station is used to configure the data acquisition and/or control scheme for a process, as well as to provide a man/machine interface for monitoring and supervising operations. It communicates with Local Processing Units over a multi-drop serial data link, collecting information which can be displayed on its CRT screen in a variety of formats or printed out if desired. A long-term and short-term data storage and retrieval capability permits in-depth analysis.

The Field Station is physically separate from the Management Station and can be located at the process up to 2500 ft. away. Here, the Local Processing Unit (LPU) operates completely independent of the Management Station once it has been configured. The measurement of analog variables and discrete events, which are the inputs to the LPU, become part of the MICROMAX database. These measurements are directed to computational algorithms to create intermediate values, labeled "pseudo points." Any input value, user-entered constant, or pseudo point can be soft-wired to interact with any of the loop, logic or data acquisition algorithms. Examples of the inputs, functions and algorithms available in an LPU include PID Control, Cascade Control, Ratio, Setpoint Programmer, Drum Sequencer, Ladder Logic, Optimization, Averaging, Totalization, etc. Working together, they form a firmware package that can be adapted to exactly fit the requirements of the process. And the physical distribution of the hardware keeps the installed cost down and system reliability high.

Look into it

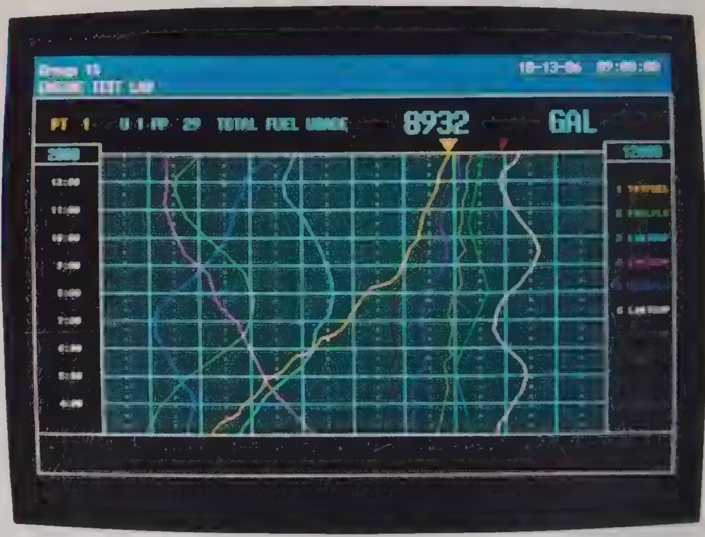
Here are some reasons why you should consider using the MICROMAX Process Management System to manage a process you're about to install or to modernize an existing process . . .



Field Station

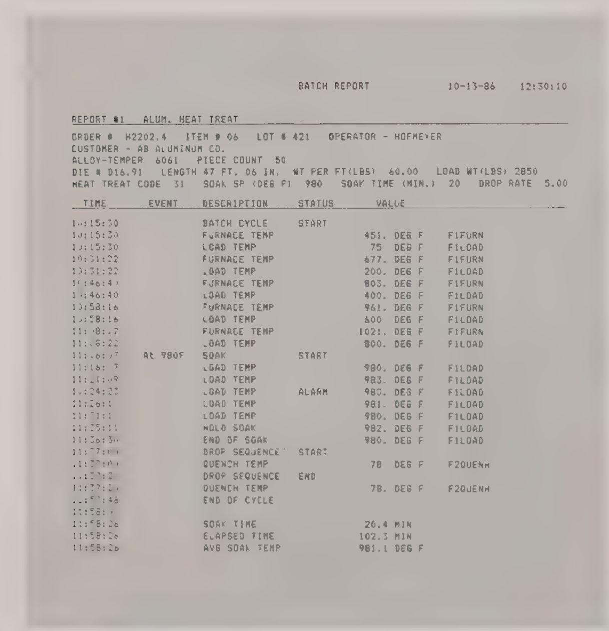
Cost effective for data acquisition and/or control.

When data acquisition is the only requirement, a MICROMAX Process Management System is competitive with strip chart recorders tracking as few as 75 points, and costs little more than ordinary data loggers. But there's really no comparison when it comes to what's provided. For example, the display is a 16-color CRT for showing a variety of graphic presentations (including several strip chart formats). Management reports can be displayed in either standard or user-configured formats. An extensive library of algorithms for computations and calculations are provided, including averaging, group averaging, math functions, etc. Inputs of different types—millivolts, volts, milliamps, discrete signals—representing process measurements—temperatures, pressures, flows—are directly accepted. All points or calculated values can be scanned for alarms. Data can be archived in real-time or data compression storage modes. The added value received from a MICROMAX makes it far more cost effective for data acquisition than any competitive approach.



Process data can be presented as a tabular list, a vertical bar graph, a horizontal trend or a vertical trend as shown.

When used to automate one or more unit processes, either batch or continuous, MICROMAX can be sized to efficiently handle as few as 2 control loops having just 15 digital inputs and outputs and 15 data points. Or it can embrace up to 64 loops where more than 1000 analog inputs and outputs and over 2000 digital inputs and outputs must be accessed. And again, offering all the advantages associated with MICROMAX, so that it does a great job for a relatively small investment.



```
                                BATCH REPORT           10-13-86    12:30:10

REPORT #1   ALUM. HEAT TREAT
ORDER #  H2202.4   ITEM # 06   LOT # 421   OPERATOR - HOFMEYER
CUSTOMER - AB ALUMINUM CO.
ALLOY-TEMPER  6061   PIECE COUNT  50
DIE # D16.91   LENGTH 47 FT. 06 IN.  WT PER FT(LBS)  60.00   LOAD WT(LBS) 2850
HEAT TREAT CODE  31   SOAK SP (DEG F)  980   SOAK TIME (MIN.)  20   DROP RATE  5.00
 TIME       EVENT     DESCRIPTION     STATUS      VALUE

10:15:30              BATCH CYCLE     START
10:15:30              FURNACE TEMP                  451. DEG F    F1FURN
10:15:30              LOAD TEMP                      75  DEG F    F1LOAD
10:31:22              FURNACE TEMP                  677. DEG F    F1FURN
10:31:22              LOAD TEMP                     200. DEG F    F1LOAD
10:46:40              FURNACE TEMP                  803. DEG F    F1FURN
10:46:40              LOAD TEMP                     400. DEG F    F1LOAD
10:58:16              FURNACE TEMP                  961. DEG F    F1FURN
10:58:16              LOAD TEMP                     600  DEG F    F1LOAD
11:08:22              FURNACE TEMP                 1021. DEG F    F1FURN
11:16:22              LOAD TEMP                     800. DEG F    F1LOAD
11:16:27   At 980F    SOAK            START
11:16: 7              LOAD TEMP                     980. DEG F    F1LOAD
11:21:09              LOAD TEMP                     983. DEG F    F1LOAD
11:24:22              LOAD TEMP       ALARM         983. DEG F    F1LOAD
11:26:1               LOAD TEMP                     981. DEG F    F1LOAD
11:31:1               LOAD TEMP                     980. DEG F    F1LOAD
11:35:11              HOLD SOAK                     982. DEG F    F1LOAD
11:36:3               END OF SOAK                   980. DEG F    F1LOAD
11:37:0               DROP SEQUENCE'  START
11:37:0               QUENCH TEMP                    78  DEG F    F2QUENH
11:37:2               DROP SEQUENCE   END
11:37:2               QUENCH TEMP                    78. DEG F    F2QUENH
11:57:48              END OF CYCLE
11:58:
11:58:26              SOAK TIME                     20.4 MIN
11:58:26              ELAPSED TIME                 102.3 MIN
11:58:26              AVG SOAK TEMP                981.1 DEG F
```

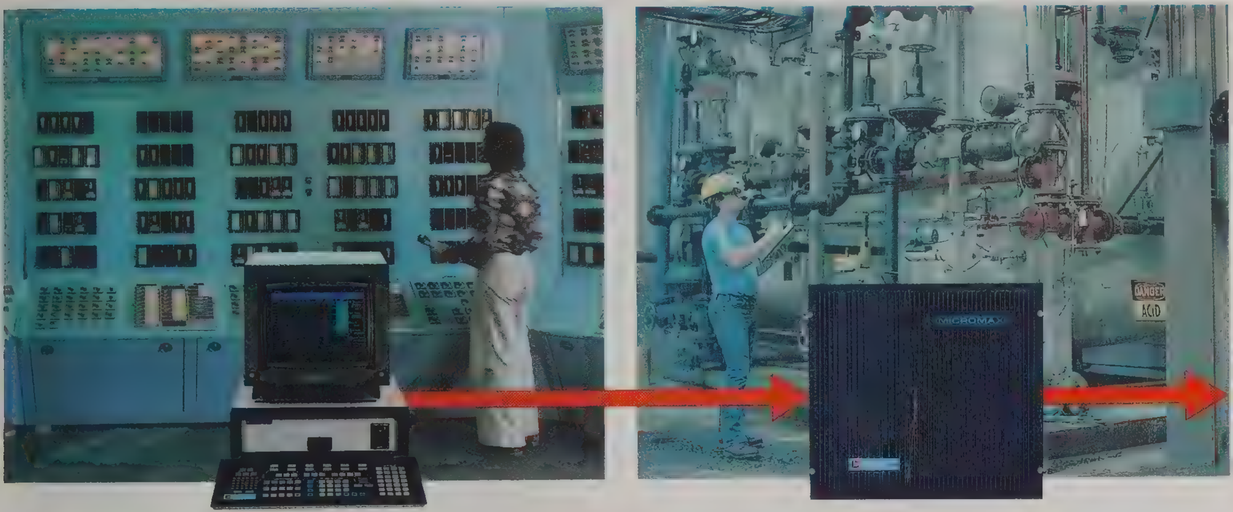
A batch report can be configured which logs selected events during a batch cycle and analog data at specific time intervals

Meets all process requirements, either batch or continuous.

A MICROMAX Process Management System embraces all the operations necessary to regulate a process and provide meaningful data. When applied to a batch process, it can be used to create a batch recipe and store the recipe on a module. With this module the recipe can be loaded at either the Management Station or at the Local Station. The process can be monitored on-line, and in the event of process upset, the operator can intervene through the Local Station or Management Station to correct the situation.

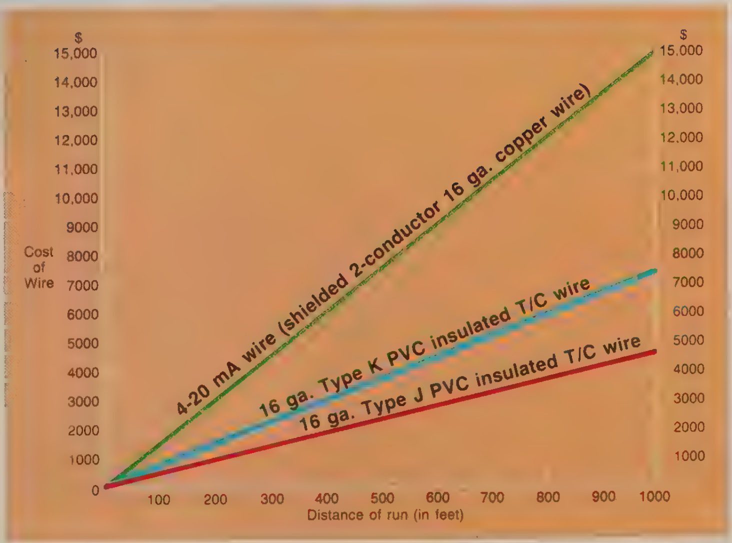
Full documentation is provided through a display and a printout of a batch report (or batch ticket) showing control parameters and time sequences. This batch ticket can be furnished either in a standard format or in one configured by the user, listing the type of material, the heat treating code, the customer's name, etc. All required operations in the preparation of this report are carried out without any expense for additional equipment.

Physically distributed hardware saves money while improving reliability.



The physical separation of the MICROMAX Management Station from the independently operational Field Stations significantly reduces installed wiring costs when compared to control equipment which is centrally located. Just the cost saving in wire alone is considerable (see chart). With MICROMAX, all measurement and control hardware is field-mounted right at the process. A single 5-wire data transmission cable connects the Local Processing Unit to the Management Station which may be located up to 2500 ft. away. There's no need for signal conditioning through transmitters.

And since the signals for the control loops don't have to travel over long distances, they are less susceptible to degradation by electrical noise as well as less vulnerable to damage. This heightened reliability coupled with the minimal wiring costs further enhances the cost effectiveness of the MICROMAX approach.



Typical Wiring Costs for 15 Points*

* does not include the cost of conduit or cable, the labor costs for installation, or the cost of any intermediate terminations which may be required

Custom control without a custom price.

By using various equipment arrangements in the Management Station and Field Station, and dovetailing input and output assignments with specific process requirements, a hardware and software package can be sized to completely manage a process in the most efficient manner possible. But it's done without any special engineering and without any sophisticated programming. The consolidation of all process management functions in a single package, the multiple combinations of digital and analog inputs and outputs, the soft-wired circuitry that makes possible an almost unlimited number of control configurations, all contribute to making MICROMAX a superior alternative to a custom system. You get a control configuration exactly sized to your process at an "off the shelf" price.

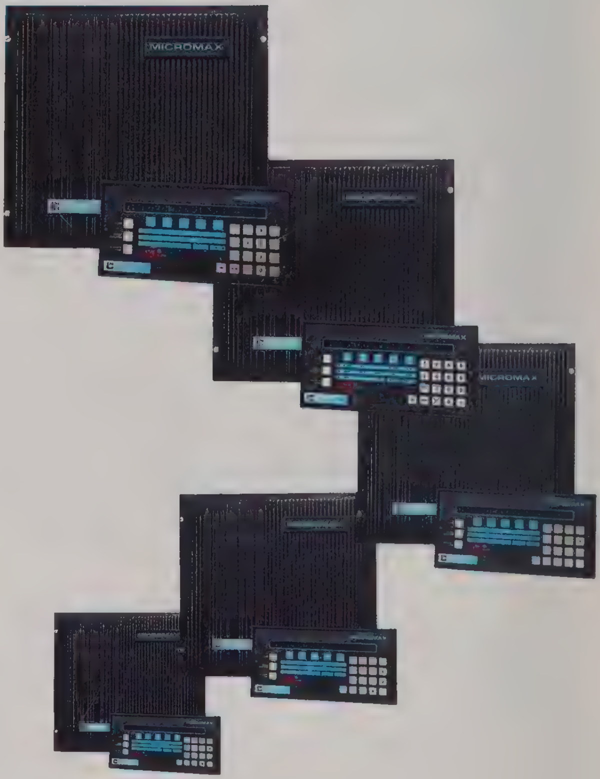
Grows as your needs grow.

Each MICROMAX Process Management System can be expanded to incorporate as many as 16 Field Stations, so it can be readily extended to new process units as they come on line. And since all 16 LPU's can be configured and monitored from the original Management Station, the savings to be realized from this shared overhead arrangement can be considerable.

If additional monitoring capability is desired, one or two Local Stations can be located at the process for each LPU, Supervisory Stations can be linked to the LPU's offering redundancy to the Management Station if desired, or a PC may be linked to the LPU's using a DATAVUE™ reporting and graphics software package. A Supervisory Station can be dedicated to specific LPU's or handle a separate management task, such as providing trend displays. Supervisory Stations have access to all current systems data and, like the Management Station, can be used to change setpoints, select and load recipes, and assume manual control. There is one exception—they can't be used to configure the Local Processing Units.

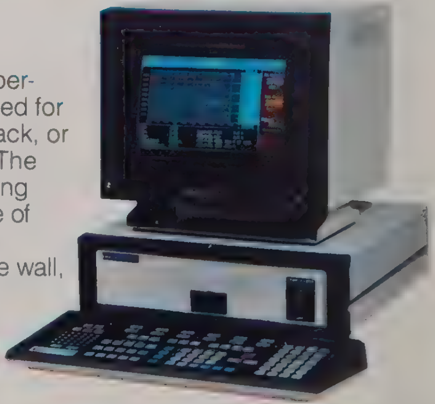
If the workload becomes too great for a single printer, a second printer can be added to the Process Management System to share printout assignments. For instance, one printer could take care of all report logging while the second printer would be dedicated exclusively to alarm logging.

These inherent capabilities, which also include serial data links to accommodate a process or personal computer or other L&N equipment, afford the user assurance that future expansion of a MICROMAX installation to encompass additional unit processes will be done quickly, simply and economically.



MICROMAX Management Station is available for mounting several ways; self-contained LPU mounts near process.

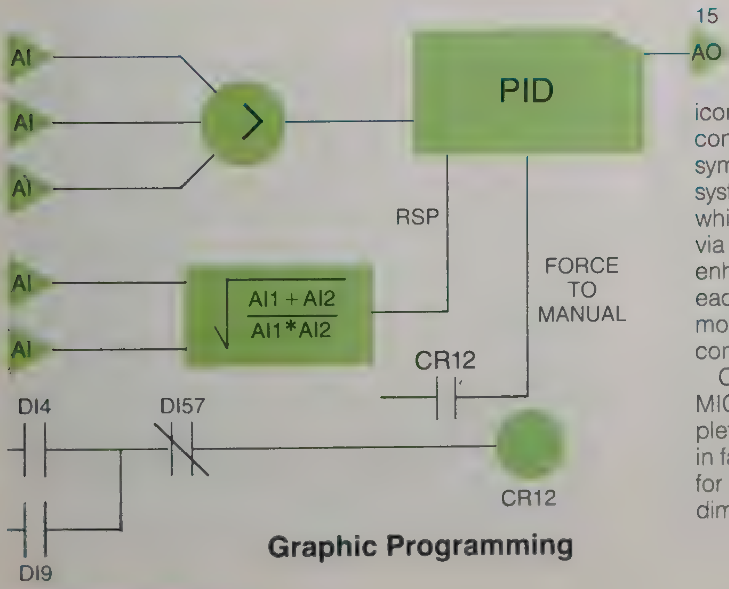
The modular MICROMAX Management Station or Supervisory Station can be supplied for mounting on a panel, in a rack, or in a tabletop arrangement. The MICROMAX Local Processing Unit is a free-standing piece of hardware housed in its own NEMA 4 cabinet that can be wall, rack, or panel mounted.



Built to work on the factory floor.

Since the Local Processing Unit is the core of the system and designed to be located at the process, it is housed in a rugged, watertight and dust-tight NEMA 4 case and built to operate over a temperature range of −10°C to 55°C (14°F to 131°F). Behind its bolt-on cover is a removable card cage allowing ready access to heavy-duty terminal boards which directly accept field wiring of up to 14-gage wire. Thermocouples and RTD's are also directly accepted without any intervening signal conditioning. For speed and ease in servicing, all printed circuit cards can be removed from the rear of the swing-out chassis without removing the input connections.

MICROMAX soft-wired technology vs. hard-wired method is no contest.



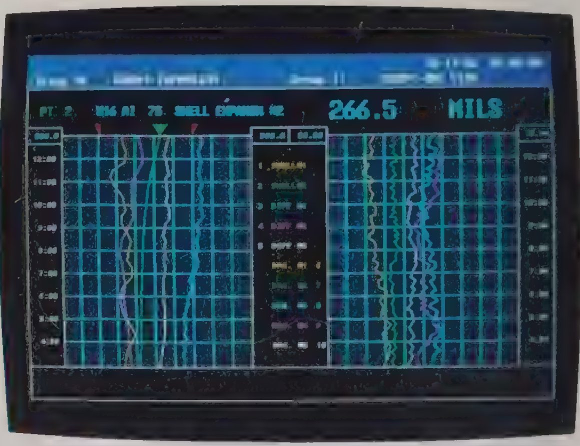
Graphic Programming

MICROMAX enables soft-wired control configurations to be created quickly and simply at the Management Station using various icons on the CRT display screen. A dynamic graphic configuration diagram enables an operator to enter symbols and shift them around to build a control system which will envelop all the variables and events which are part of the process. This technique of wiring via software results in a control configuration which enhances productivity because it's exactly fitted to each particular operation. And if the process changes, modifications can be made just as easily as the initial configuration.

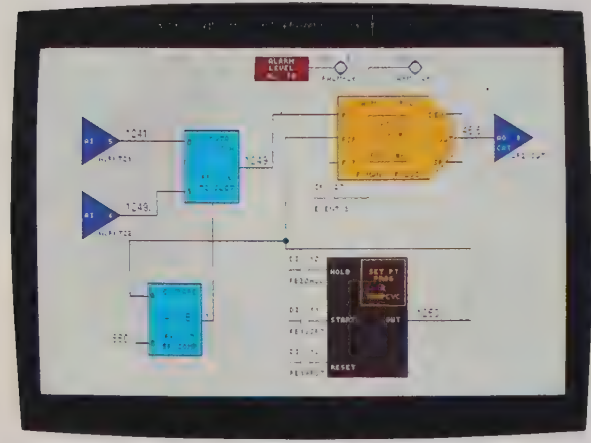
Compared to hard-wired installations, the soft-wired MICROMAX Field Station (which operates with complete independence once configured) can be installed in far less time—at a much lower cost. And the flexibility for quick reconfiguration whenever it's required adds a dimension not available in any hard-wired installation.

A variety of screen displays and printouts give you a good look at the process.

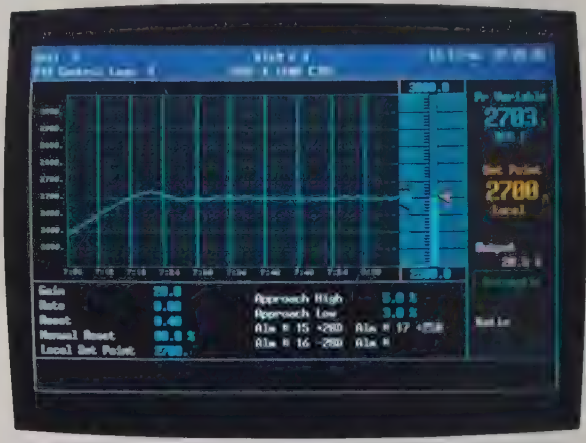
You get a closer, clearer view of process dynamics through the windows of numerous screen displays. Pictured are a number of the screens available for information management and supervisory control.



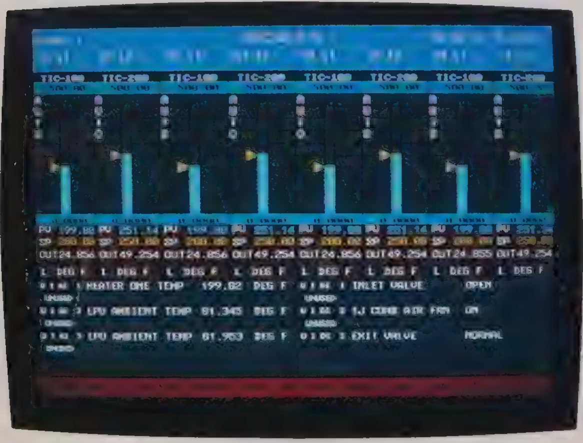
A vertical trend format emulates a strip chart recorder with a single scale, a dual scale (shown) or a triple scale to aid in grouping related point data.


ALARM LEVEL
HOLD
SET PT
START
OUT
RESET

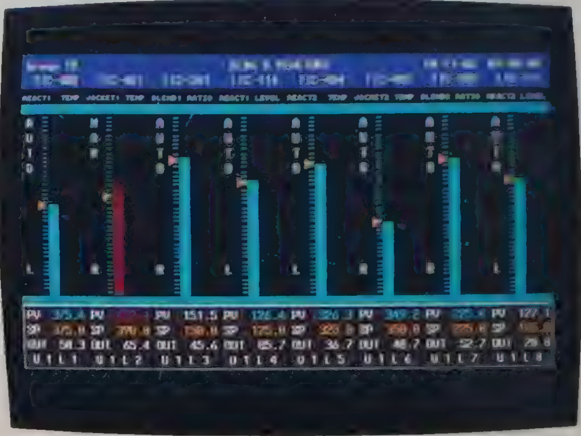
Set-up screens are available where function block icons can be positioned graphically and soft-wired to configure new control schemes or modify existing ones quickly and simply.


2703
2700
Gain
Rate
Reset
Manual Reset
Local Set Point
Approach High
Approach Low

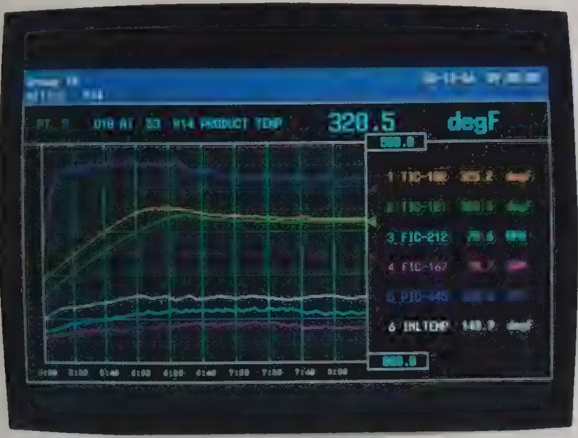
A single loop of control is directly supervised through trending of the controlled variable. When called for, the setpoint can be adjusted, a manual override introduced, or a ratio value altered (where ratio control has been selected).



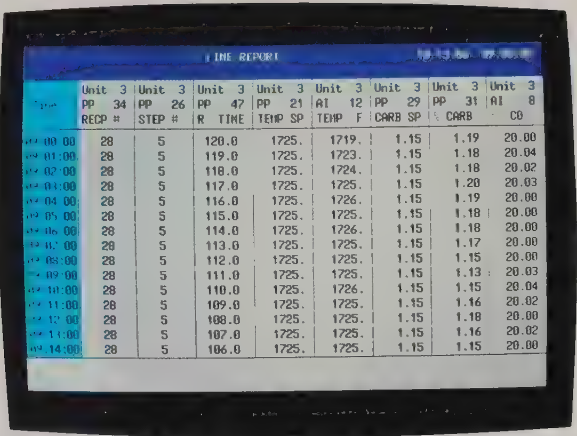
A bar/status display provides an overview of process operations from which control loop parameters can be changed, plus related analog/discrete status indicated.



A bar graph display enables the operator to view the status of a defined group of control loops, and change setpoints and other control parameters



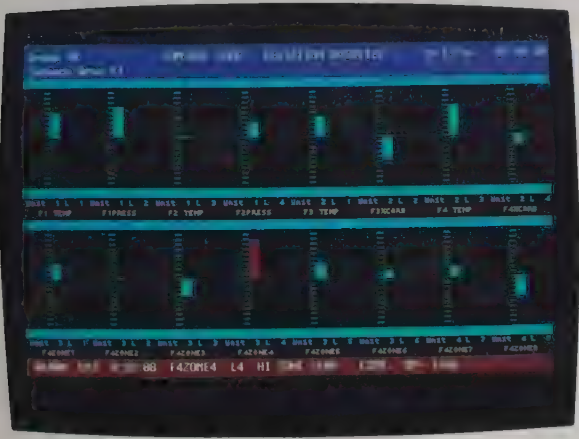
Up to 6 points can be trended in a horizontal format .



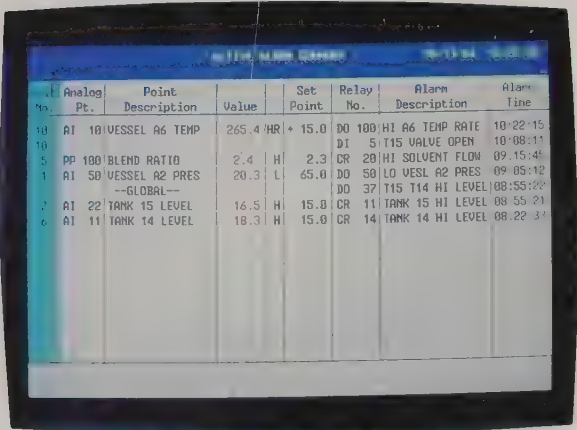
LINE REPORT

Time	Unit 3 PP 34 RECP #	Unit 3 PP 26 STEP #	Unit 3 PP 47 R TIME	Unit 3 PP 21 TEMP SP	Unit 3 AI 12 TEMP F	Unit 3 PP 29 CARB SP	Unit 3 PP 31 % CARB	Unit 3 AI 8 CO
00:00	28	5	120.0	1725.	1719.	1.15	1.19	20.00
01:00	28	5	119.0	1725.	1723.	1.15	1.18	20.04
02:00	28	5	118.0	1725.	1724.	1.15	1.18	20.02
03:00	28	5	117.0	1725.	1725.	1.15	1.20	20.03
04:00	28	5	116.0	1725.	1726.	1.15	1.19	20.00
05:00	28	5	115.0	1725.	1725.	1.15	1.18	20.00
06:00	28	5	114.0	1725.	1726.	1.15	1.18	20.00
07:00	28	5	113.0	1725.	1725.	1.15	1.17	20.00
08:00	28	5	112.0	1725.	1725.	1.15	1.15	20.00
09:00	28	5	111.0	1725.	1725.	1.15	1.13	20.03
10:00	28	5	110.0	1725.	1726.	1.15	1.15	20.04
11:00	28	5	109.0	1725.	1725.	1.15	1.16	20.02
12:00	28	5	108.0	1725.	1725.	1.15	1.18	20.00
13:00	28	5	107.0	1725.	1725.	1.15	1.16	20.02
14:00	28	5	106.0	1725.	1725.	1.15	1.15	20.00

Line reports of up to 24 parameters logged at specified intervals can be displayed 8 columns at a time—you tab across the screen to view all 24 columns.

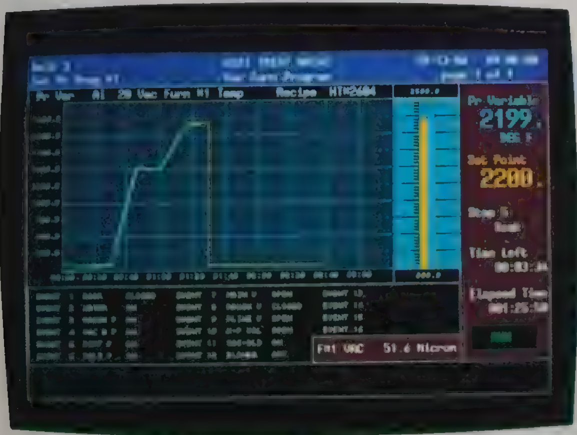


All alarms—whether global or from individual Local Processing Units—are reported via a flashing red stripe which will appear at the bottom of any display screen.

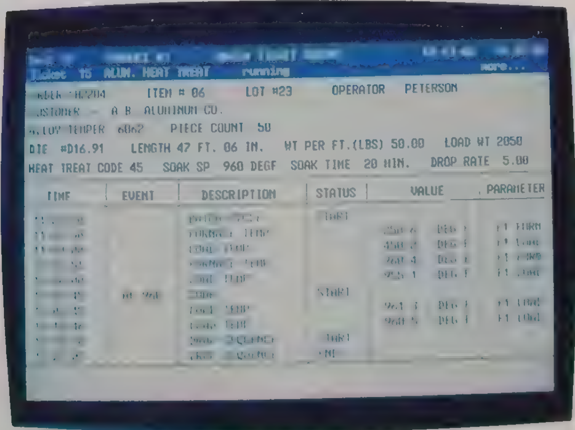


No.	Analog Pt.	Point Description	Value		Set Point	Relay No.	Alarm Description	Alarm Time
10	AI 10	VESSEL A6 TEMP	265.4	HR	+ 15.0	DO 100	HI A6 TEMP RATE	10:22:15
10						DI 5	T15 VALVE OPEN	10:08:11
5	PP 100	BLEND RATIO	2.4	H	2.3	CR 20	HI SOLVENT FLOW	09.15:4[illegible]
1	AI 50	VESSEL A2 PRES	20.3	L	65.0	DO 50	LO VESL A2 PRES	09 05:12
		--GLOBAL--				DO 37	T15 T14 HI LEVEL	08:55:22
2	AI 22	TANK 15 LEVEL	16.5	H	15.0	CR 11	TANK 15 HI LEVEL	08 55 21
6	AI 11	TANK 14 LEVEL	18.3	H	15.0	CR 14	TANK 14 HI LEVEL	08.22 3[illegible]

Both an active alarm summary (shown) and a historical alarm summary are available to display in a consolidated format parameters currently in alarm or previously alarmed



On a setpoint program screen, the actual process variable is plotted and displayed with the projected setpoint program for ready comparison



Ticket 15 ALUM. HEAT TREAT running more...

ITEM # 06 LOT #23 OPERATOR PETERSON

CUSTOMER – A B ALUMINUM CO.

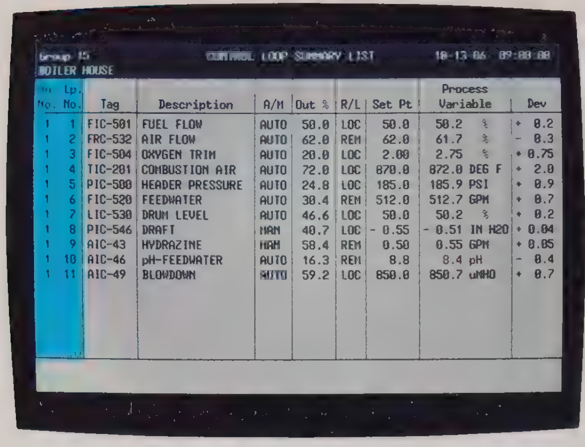
ALLOY TEMPER 6062 PIECE COUNT 50

DIE #D16.91 LENGTH 47 FT. 06 IN. WT PER FT.(LBS) 50.00 LOAD WT 2050

HEAT TREAT CODE 45 SOAK SP 960 DEGF SOAK TIME 20 MIN. DROP RATE 5.00

TIME | EVENT | DESCRIPTION | STATUS | VALUE | PARAMETER

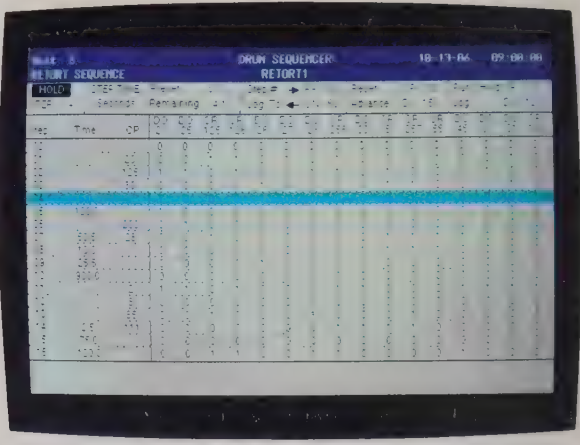
A display of a batch ticket report includes an area for user-defined batch information to identify sequentially recorded process variables and events



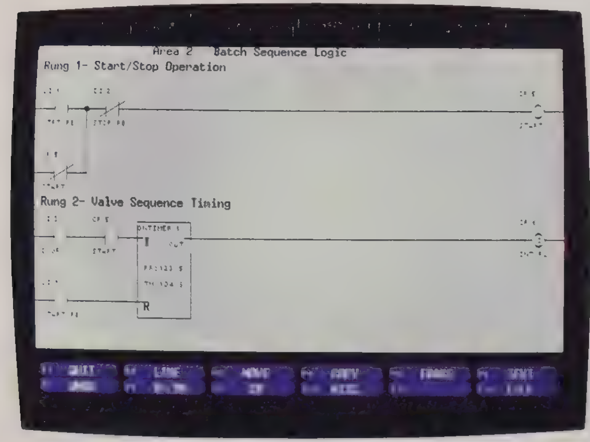
Group 15 CONTROL LOOP SUMMARY LIST 10-13-86 09:08:08
BOILER HOUSE

Un No.	Lp. No.	Tag	Description	A/M	Out %	R/L	Set Pt	Process Variable	Dev
1	1	FIC-501	FUEL FLOW	AUTO	50.0	LOC	50.0	50.2 %	+ 0.2
1	2	FRC-532	AIR FLOW	AUTO	62.0	REM	62.0	61.7 %	- 0.3
1	3	FIC-504	OXYGEN TRIM	AUTO	20.0	LOC	2.00	2.75 %	+ 0.75
1	4	TIC-201	COMBUSTION AIR	AUTO	72.0	LOC	870.0	872.0 DEG F	+ 2.0
1	5	PIC-500	HEADER PRESSURE	AUTO	24.8	LOC	185.0	185.9 PSI	+ 0.9
1	6	FIC-520	FEEDWATER	AUTO	30.4	REM	512.0	512.7 GPM	+ 0.7
1	7	LIC-530	DRUM LEVEL	AUTO	46.6	LOC	50.0	50.2 %	+ 0.2
1	8	PIC-546	DRAFT	MAN	40.7	LOC	- 0.55	- 0.51 IN H20	+ 0.04
1	9	AIC-43	HYDRAZINE	MAN	58.4	REM	0.50	0.55 GPM	+ 0.05
1	10	AIC-46	pH-FEEDWATER	AUTO	16.3	REM	8.8	8.4 pH	- 0.4
1	11	AIC-49	BLOWDOWN	AUTO	59.2	LOC	850.0	850.7 uMHO	+ 0.7

A control loop summary shows the status of up to 16 loops, and allows the operator to select auto/manual or remote/local and alter manual output and local setpoint.

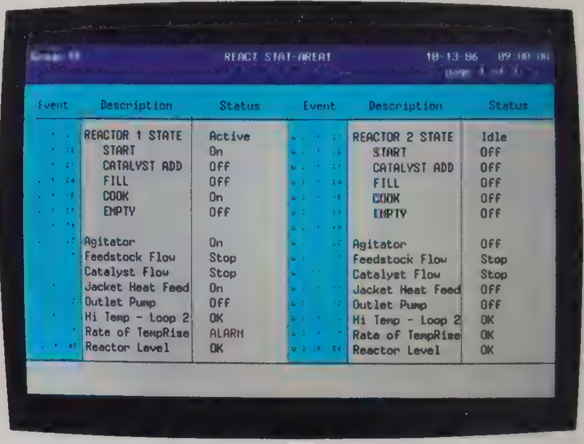


A drum sequencer function used to reduce the amount of logic programming for sequential operations is monitored on its own display screen.



Area 2 Batch Sequence Logic
Rung 1- Start/Stop Operation
Rung 2- Valve Sequence Timing
R

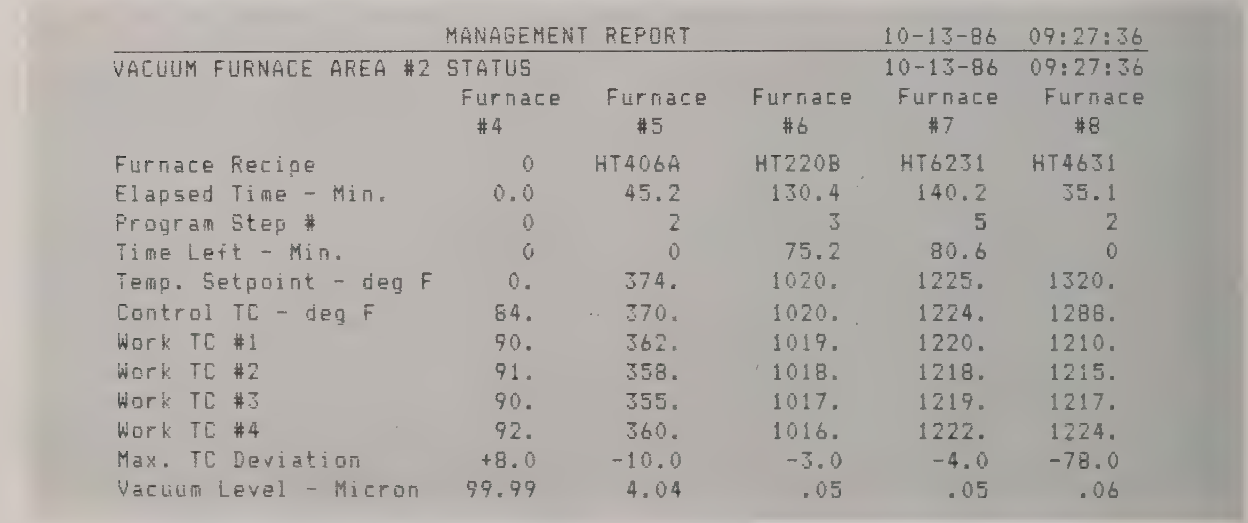
Ladder diagram displays indicating the power flow permit graphic programming of logic.



REACT STAT-AREA1 10-13-86 09:00:00
page 1 of 3

Event	Description	Status	Event	Description	Status
[illegible]	REACTOR 1 STATE	Active	[illegible]	REACTOR 2 STATE	Idle
[illegible]	START	On	[illegible]	START	Off
[illegible]	CATALYST ADD	Off	[illegible]	CATALYST ADD	Off
[illegible]	FILL	Off	[illegible]	FILL	Off
[illegible]	COOK	On	[illegible]	COOK	Off
[illegible]	EMPTY	Off	[illegible]	EMPTY	Off
[illegible]	Agitator	On	[illegible]	Agitator	Off
[illegible]	Feedstock Flow	Stop	[illegible]	Feedstock Flow	Stop
[illegible]	Catalyst Flow	Stop	[illegible]	Catalyst Flow	Stop
[illegible]	Jacket Heat Feed	On	[illegible]	Jacket Heat Feed	Off
[illegible]	Outlet Pump	Off	[illegible]	Outlet Pump	Off
[illegible]	Hi Temp - Loop 2	OK	[illegible]	Hi Temp - Loop 2	OK
[illegible]	Rate of TempRise	ALARM	[illegible]	Rate of TempRise	OK
[illegible]	Reactor Level	OK	[illegible]	Reactor Level	OK

A logic table display shows the status of major events in a batch process.

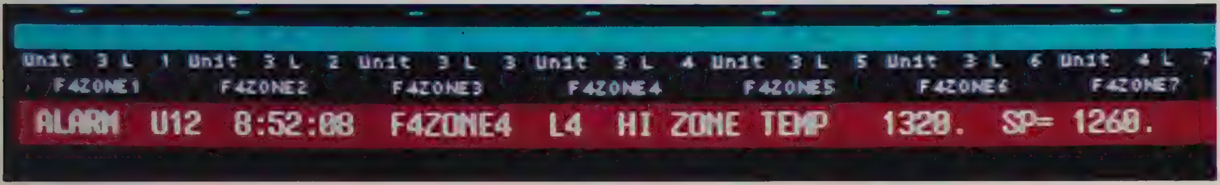


```
                          MANAGEMENT REPORT                  10-13-86   09:27:36
VACUUM FURNACE AREA #2 STATUS                                10-13-86   09:27:36
                           Furnace    Furnace    Furnace    Furnace    Furnace
                             #4         #5         #6         #7         #8

Furnace Recipe                 0      HT406A     HT220B     HT6231     HT4631
Elapsed Time - Min.          0.0       45.2      130.4      140.2       35.1
Program Step #                 0          2          3          5          2
Time Left - Min.               0          0       75.2       80.6          0
Temp. Setpoint - deg F        0.       374.      1020.      1225.      1320.
Control TC - deg F           84.       370.      1020.      1224.      1288.
Work TC #1                   90.       362.      1019.      1220.      1210.
Work TC #2                   91.       358.      1018.      1218.      1215.
Work TC #3                   90.       355.      1017.      1219.      1217.
Work TC #4                   92.       360.      1016.      1222.      1224.
Max. TC Deviation           +8.0      -10.0       -3.0       -4.0      -78.0
Vacuum Level - Micron      99.99       4.04        .05        .05        .06
```

A free-form management report is configured by the user as to what data is to be entered—useful in providing a custom process overview, a summary of utilization, the status of several operations, etc.

Extensive alarm network can be configured to handle all situations.



```
Unit  3 L  1 Unit  3 L  2 Unit  3 L  3 Unit  3 L  4 Unit  3 L  5 Unit  3 L  6 Unit  4 L  7
  F4ZONE1        F4ZONE2        F4ZONE3        F4ZONE4        F4ZONE5        F4ZONE6        F4ZONE7
ALARM  U12  8:52:08  F4ZONE4  L4  HI ZONE TEMP   1320.  SP= 1260.
```

The MICROMAX Management Station provides alarm information of all types, including analog level, deviation, open inputs, discrete, rate of change, or based on calculations. Alarms are time-stamped and directed to relays in the LPU, if desired, then reported to the Management Station which also has a common alarm relay for connection to a horn or other alarm device.

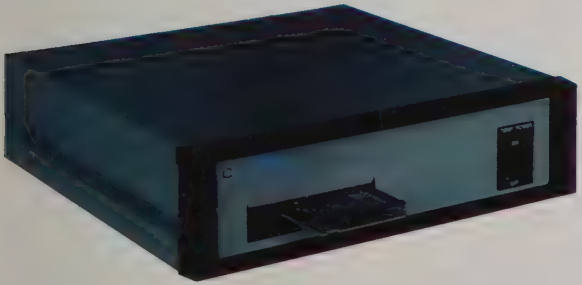
To alert the operator, all alarms are announced with a flashing red stripe which appears at the bottom of any screen currently on display. At the same time they can be routed to a printer for logging. A two-line area is reserved on each screen to permit display of an alarm, reportable event, open input and diagnostic fault).

When an alarm is announced, the operator silences the station horn with an Acknowledge key which also calls up on the screen either a summary of all active alarms or a preselected screen with associated process data. Using this information he can respond quickly to correct off-normal conditions.

The operator can depress an Alarm Summary key at any time to view a listing of all active alarms (up to 150) or the last 50 alarms which have cleared.

With MICROMAX, a comprehensive alarm network can be configured for each application which will assure a continuing high level of security.

Process data can be stored and retrieved at will…in the format of your choice.



Residing within the Management Station is adequate memory storage capacity for handling labels, tags, current trends, limited reports and configuration programs for all Local Processing Units. But an optional Data Storage Unit adds the capability to also store data on a historical basis, to maintain backup copies of configuration programs stored in the Management Station, and to expand the number of recipes available beyond those contained in a recipe module.

Short-term historical information such as trends of data gathered over the past 48 hours (as compared to current trend data), can be stored on a 45-megabyte hard disk. There is also a 60-megabyte removable tape cartridge for the storage of data on a long term basis as archival information or as backup to the hard disk.

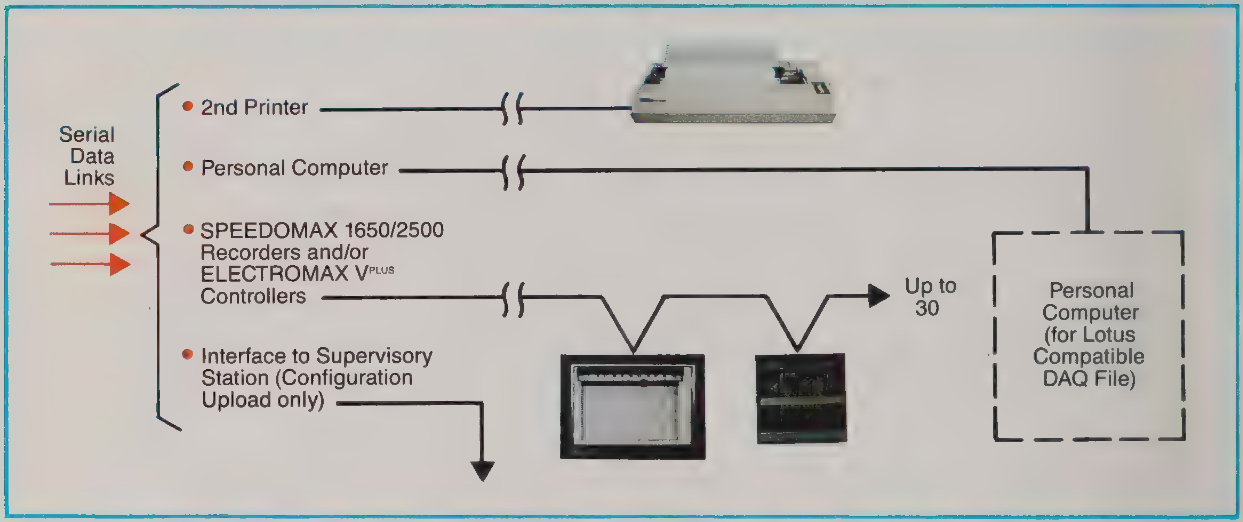
Data can be stored in its entirety or, for greater efficiency, compressed into meaningful samples. Data compression can take the form of periodic samples, averaged values over a specified time period, or high and low readings, enabling you to archive significant quantities of critical process information.

Stored data is readily retrievable from either the disk or tape cartridge for display in a selection of formats. For example, information could be presented as a tabular report, a vertical recorder-like trend, a horizontal trend, a bar chart, a tabular list, a batch report, or a management report.

The Data Storage Unit offers substantial information storage capacity, the ability to store complete or compressed blocks of data, ease of retrieval, and the inherent capability to present retrieved data in a number of formats. It adds an important new dimension to the management of process information.

Completely compatible with existing instrumentation.

Where L&N Speedomax recorders or Electromax V^{PLUS} single-loop controllers are already in place, or are planned additions, the instruments can be incorporated into the MICROMAX Process Management System via serial communications to a port in the Electronics Unit. As many as 30 instruments located as far away as 1000 ft. can be accommodated on a single data link. One, two, or three low-speed serial ports are available to interface MICROMAX with a personal computer and an additional printer.


Serial Data Links
2nd Printer
Personal Computer
SPEEDOMAX 1650/2500 Recorders and/or ELECTROMAX V^PLUS Controllers
Interface to Supervisory Station (Configuration Upload only)
Up to 30
Personal Computer (for Lotus Compatible DAQ File)

Can be effectively applied to almost any unit process.

We've listed some typical applications which would benefit from the MICROMAX approach. However, these applications simply scratch the surface—opportunities exist in hundreds of unit processes to use the MICROMAX Process Management System effectively.

Process Management

- Furnaces/Ovens/Kilns
- Chemical Reactors
- Boilers
- Glass Manufacturing Operations
- Autoclaves
- Pilot Plants
- Environmental Test Chambers

Data Management

- Turbine/Generator Monitoring
- Temperature Profiling
- Process Monitoring
- Distillation Columns
- Performance Analysis
- Analytical Chemistry

. . . and many more.

More detailed information, including specifications, can be found in the MICROMAX Data Booklet, available from your nearest Leeds & Northrup Sales Representative. Ask for booklet GO.0001-DB. Also, Data Sheet GO.0003-DS describes DATAVUE™ Software for MICROMAX Process Management Systems.

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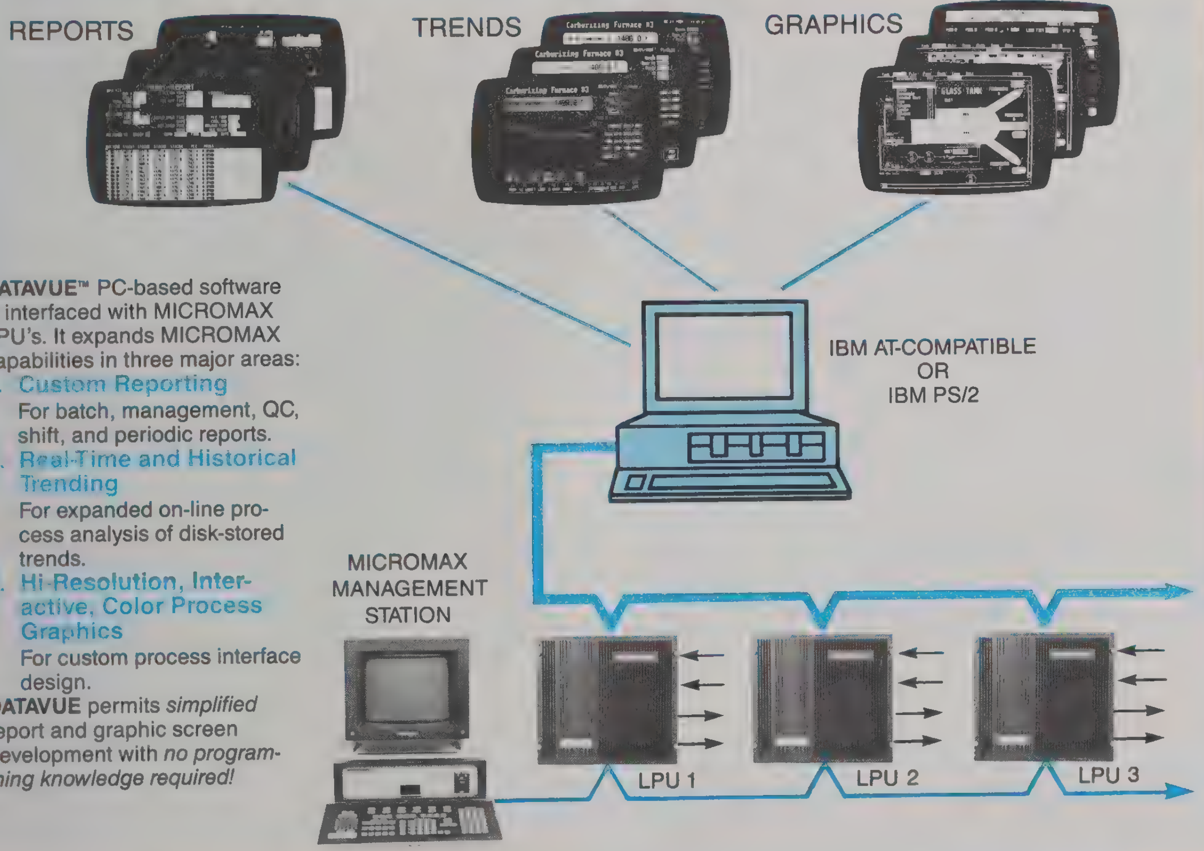
GO.0003-DS

DATAVUE™ Software for MICROMAX® Process Management Systems



DATAVUE™ PC-based software is interfaced with MICROMAX LPU's. It expands MICROMAX capabilities in three major areas:

1. **Custom Reporting**
   For batch, management, QC, shift, and periodic reports.
2. **Real-Time and Historical Trending**
   For expanded on-line process analysis of disk-stored trends.
3. **Hi-Resolution, Interactive, Color Process Graphics**
   For custom process interface design.

DATAVUE permits *simplified* report and graphic screen development with *no programming knowledge required!*

Major Features:

- **Supports LPU networking** Provides data access to multiple LPU's via an RS-485 network.
- **Standard PC hardware support** IBM "AT" compatible or IBM PS/2 hardware plus DOS, no special hardware/software additions.
- **Process interface redundancy** Multiple serial ports in the LPU allow PC-based DATAVUE and the Management Station to view the same data and interact with control loops.
- **Mouse-driven screen editing** For fast screen development and menu selections.
- **On-line editing/backgrounding of report/trend data** Data acquisition to disk files is independent of DOS allowing on-line screen editing without data loss.
- **Pixel-resolution process graphics** Use 16 colors for EGA or VGA graphics to pixel resolution.

Continued

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DATAVUE™ Software

Major Features Continued

- **On-line data archiving** DIF converted data files can be archived to diskette for off-line analysis using spreadsheet software such as LOTUS 1-2-3.
- **Icon library** Placement, sizing and rotating of standard icons such as valves, pumps, tanks, and bar charts simplifies screen design, or build your own and save in library.
- **Standard data/loop template formats** Formats included for PID loop plus group data bar graph and sizeable trend graph templates.
- **Flexible graphics screen animation** Bar charts for any shape, moving setpoint indicators, color changes, messages, blinking, and sound are easily created to show process changes or alert the operator.
- **Free placement of trend graphs** A trend graph can be sized to be anywhere on screen.
- **Flexible operator interface design** Create screen hierarchy and operator/screen interaction using redefinable function keys or "hot spots" and user-defined ENTER fields sensitive to mouse or cursor selection.
- **Flexible alarming** The latest two alarm messages can be placed anywhere on screens; also standard alarm summary/history screens provided.
- **On-screen floating point calculations** For screen animation or reporting of dynamic data from multiple LPUs.
- **Batch parameter loading** Screens can be created to download LPU writeable parameters such as "constant values" to change batch setpoints, tuning constants, etc.
- **Simple MICROMAX LPU Data Access** Automatic generation of database reference files and mouse selection from pop-up LPU parameter menus simplifies data selection for placement on screen.
- **Graphic printout** Print any graphic screen with colors represented in shades of gray.
- **Power fail recovery** Data collection continues for trends and reports after power loss.
- **On-line labelling screens** For parameter tags, descriptors, and on-off labels.
- **Security** Password protection for editing function, create your own for parameter entry.

General Description

DATAVUE is a comprehensive PC-based software package that complements the reporting, trending, and alarming capabilities of the MICROMAX Process Management System. It also expands the operator interface to the realm of high-resolution, interactive process graphics. Mouse-driven screen development utilizing pull-down menus and windowed MICROMAX parameter lists allow you to design screens quickly without any programming knowledge. A DATAVUE software package is available in two versions: Reports/Trends offering no graphics drawing capability, or Reports/Trends/Graphics offering all of the package features.

The versatility of DATAVUE's software can range from pure data acquisition and process analysis utilizing custom report formats and trends to complete supervision of processes through high resolution process graphic displays and menu lists. Its high-speed link to multiple MICROMAX LPU's using a standard PC serial communications port offers real-time access to process data for monitoring only, or for interactive control of process loops and parameter changes from any screen. Since DATAVUE normally accesses data from the optional LPU communication port it can be assigned a task totally independent of the MICROMAX Management Station or offer process interface redundancy.

Data collection for reports and trends is run as a background task independent of DOS. This allows screens to be developed or edited concurrently without loss of important process data. Data stored to a disk file can be converted on-line to a DIF format, then archived to a floppy disk allowing the data to be analyzed off-line using spreadsheet software.

DATAVUE also lets you get on-line quickly. For data acquisition, predawn templates of data bar graph and trend formats are provided, alterable if desired. Report formats or tabular

General Description Continued

data screens are generated in a freeform manner. In addition, database references for LPU data are automatically generated while other local database files can be simply developed if necessary. Advanced graphic drawing features and simplified animation tools speed custom graphics development for mimicking of process operations. Features such as Function-key definition by menu selection and free placement of "hot spots" for screen areas responsive to a mouse or cursor selection also allow fast creation of hierarchical menus and operator prompts to simplify the operator interface.

Control interaction with the process is easily developed on any screen for changing setpoints, assuming manual control, starting or stopping setpoint programs, forcing an I/O status, or entering related process parameter changes. To further speed the control interface development, a standard control loop detail screen with an integral trend plot and a faceplate template applicable to any loop are provided.

As a result of its versatility and extensive capability, DATAVUE software enables you to define how MICROMAX data is to be reported, displayed, and interacted upon to increase the efficiency of your process operations.

Custom Reporting

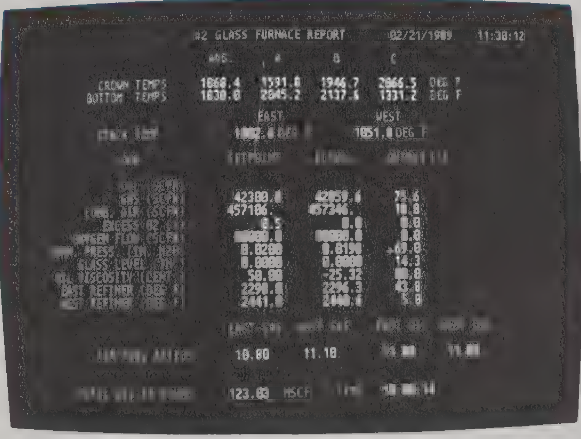
Reporting Features:

- **Up to 50 concurrent reports.**
- **Freeform entry of text and data on screen.**
- **Assignable field width optimizes parameter resolution.**
- **Simple LPU data placement from menus.**
- **Full 8½″ x 11″ thru 11″ x 13½″ formats.**
- **Optional appended batch log report, up to 24 parameters wide and 9999 sample lines.**
- **Operator on-line data/text ENTER fields assignable with field length.**
- **On-screen calculations updated on logging or report completion or combined with LPU calculations.**
- **Start/stop and print/store to disk on day/time, interval, alarm, or event.**
- **Report data convertible to spreadsheet compatible format (DIF format).**
- **On-line review of historical reports with comment/text entry.**
- **Automatic generation of disk files for repetitive cycles (up to 26).**

DATAVUE's freeform reporting allows you to design your own formats for screen presentation and normal (80 column) or wide-carriage printouts. "Grid snapping" automatically aligns text strings and data fields as necessary for proper spacing. Page Up and Down keys or cursor/mouse-directed "sliders" allow access to report areas off screen when necessary. MICROMAX data values such as analog inputs, pseudo-point calculations, timer/counter values, constants, etc. or discrete on/off status labels may be positioned anywhere on the report for dynamic updating (Fig. 1). Calculations such as averages, deviations, etc., may be performed on screen data while the report screen is viewed or at the time the report data is periodically logged or full report completed.

For batch reporting or periodic logging, up to 24 parameters may be logged to disk at specified intervals ranging from seconds to hours. These values appear as

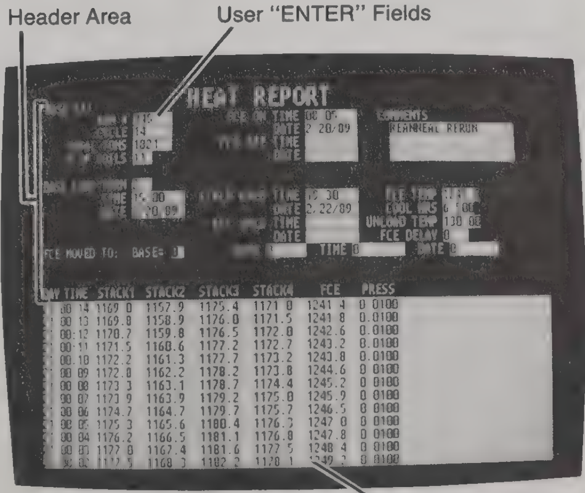
(Continued)



```
#2 GLASS FURNACE REPORT      02/21/1989    11:30:12

CROWN TEMPS     1868.4   1591.8   1946.7   2066.5  DEG F
BOTTOM TEMPS    1830.8   2045.2   2137.6   1331.2  DEG F
                    EAST                 WEST
```

Fig. 1. Management-Type Report.



```
HEAT REPORT
COMMENTS
REANNEAL RERUN

FCE MOVED TO:  BASE= 0

DAY TIME  STACK1  STACK2  STACK3  STACK4   FCE    PRESS
   00 14  1169.0  1157.9  1175.4  1171.0  1241.4  0.0100
   00 13  1169.8  1158.9  1176.0  1171.5  1241.8  0.0100
   00:12  1170.7  1159.8  1176.5  1172.0  1242.6  0.0100
   00:11  1171.5  1160.6  1177.2  1172.7  1243.2  0.0100
   00.10  1172.2  1161.3  1177.7  1173.2  1243.8  0.0100
   00 09  1172.8  1162.2  1178.2  1173.8  1244.6  0.0100
   00 08  1173.3  1163.1  1178.7  1174.4  1245.2  0.0100
   00 07  1173.9  1163.9  1179.2  1175.0  1245.9  0.0100
   00 06  1174.7  1164.7  1179.7  1175.7  1246.5  0.0100
   00 05  1175.3  1165.6  1180.4  1176.3  1247.0  0.0100
   00 04  1176.2  1166.5  1181.1  1176.8  1247.8  0.0100
   00 03  1177.0  1167.4  1181.6  1177.5  1248.4  0.0100
```

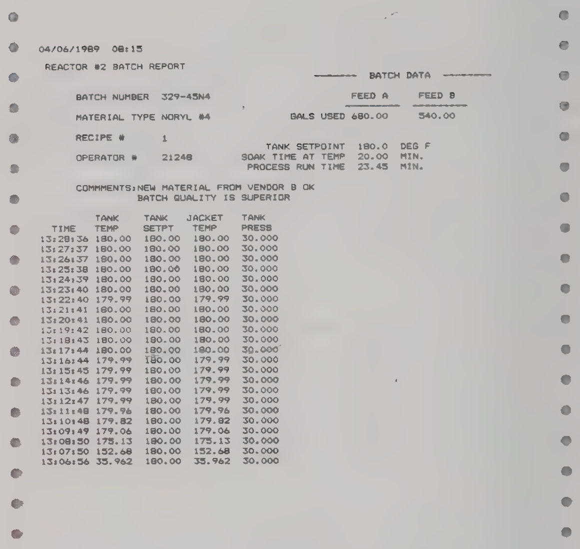
Fig. 2. Batch-Type Report.

Custom Reporting Continued

line data appended to a custom report header which may contain other information relative to the batch (Fig. 2). "ENTER" fields may be designated for operator screen entry of batch data (material type, load number, weights, etc.), operator comments, setpoint, recipe values, lab data, etc. which may be added to running or historical reports. The batch logging format is typical of reporting requirements for annealing ovens, batch reactors, batch furnaces, QC logs, or shift reports.

The operator may schedule a report to run (data starts to be logged to a disk file) or be stopped based on day of week and time or on event (CR, DI, DO status change). Alternatively, a report may be started or stopped from any screen. Reports may be printed on completion (Fig. 3) and/or stored to disk for later screen recall, review, comment additions, and printout. Periodic logs, typical of shift reports, may be printed with a history log of data over the time interval.

Reports may be archived on-line to floppy disk or restored to disk from floppy disk for review on-screen. On-line DIF file conversion of report data is selectable prior to archiving.



```
04/06/1989  08:15
 REACTOR #2 BATCH REPORT
                                                 ------- BATCH DATA -------

      BATCH NUMBER  329-45N4                           FEED A     FEED B
                                                       --------   --------
      MATERIAL TYPE NORYL #4                 GALS USED 680.00     540.00

      RECIPE #       1
                                          TANK SETPOINT  180.0  DEG F
      OPERATOR #    21248           SOAK TIME AT TEMP    20.00  MIN.
                                     PROCESS RUN TIME    23.45  MIN.

      COMMMENTS:NEW MATERIAL FROM VENDOR B OK
                 BATCH QUALITY IS SUPERIOR

           TANK     TANK     JACKET   TANK
  TIME     TEMP     SETPT    TEMP     PRESS
13:28:36 180.00   180.00   180.00   30.000
13:27:37 180.00   180.00   180.00   30.000
13:26:37 180.00   180.00   180.00   30.000
13:25:38 180.00   180.00   180.00   30.000
13:24:39 180.00   180.00   180.00   30.000
13:23:40 180.00   180.00   180.00   30.000
13:22:40 179.99   180.00   179.99   30.000
13:21:41 180.00   180.00   180.00   30.000
13:20:41 180.00   180.00   180.00   30.000
13:19:42 180.00   180.00   180.00   30.000
13:18:43 180.00   180.00   180.00   30.000
13:17:44 180.00   180.00   180.00   30.000
13:16:44 179.99   180.00   179.99   30.000
13:15:45 179.99   180.00   179.99   30.000
13:14:46 179.99   180.00   179.99   30.000
13:13:46 179.99   180.00   179.99   30.000
13:12:47 179.99   180.00   179.99   30.000
13:11:48 179.96   180.00   179.96   30.000
13:10:48 179.82   180.00   179.82   30.000
13:09:49 179.06   180.00   179.06   30.000
13:08:50 175.13   180.00   175.13   30.000
13:07:50 152.68   180.00   152.68   30.000
13:06:56 35.962   180.00   35.962   30.000
```

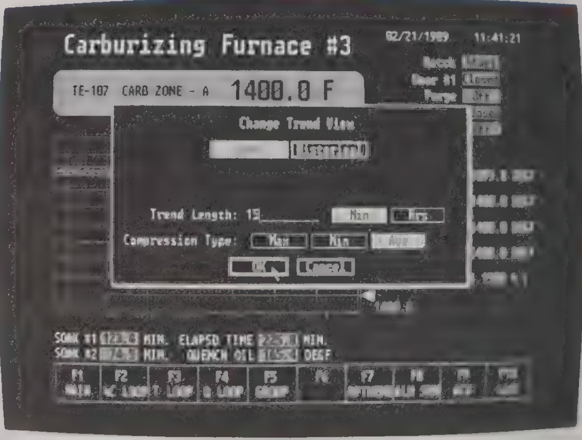
Fig. 3. Batch Report Printout.

Trending

Trending Features:

- **Up to 50 concurrent trend screens.**
- **Sample rates of 2 to 999999 seconds.**
- **Color selection for each trend plot.**
- **Horizontal or vertical trend formats; up to 12 parameters.**
- **Special horizontal template format with rotating trend parameter window and indicators of alarm setpoints.**
- **Trend graphs sizeable to fit on any tabular or graphic display.**
- **Trend data stored to disk.**
- **Trend data files convertible on-line to DIF format, spreadsheet compatible.**
- **On-line selection of trend time window.**
- **On-line selectable data compression on trend plotting; real-time or historical trend data for a selected time window plotted as averaged data or highest/lowest values of data samples obtained.**
- **Trend dots automatically connected for small time windows.**
- **Trend start/stop on time or event or by function key/hot spot access to trend menus.**
- **Trend lines turn to red on alarm.**

DATAVUE provides both real-time and historical trending for analyzing process changes over time. The operator may select a new time-window on-line using the "trend view" feature for narrowing or expanding the trend view (Fig. 4). Depending on time window span and sample rate, selectable data compression can improve analysis of process changes by plotting the average of data samples between plotted points, or the highest/lowest values. In this way, the maximum process excursions can be viewed on expanded trend views. This data compression can also be selected on-line for historical trend review. The operator may select a historical trend file on-line based on date and time and the desired time window such as 30 minutes, 1



Carburizing Furnace #3

02/21/1989 11:41:21

TE-107 CARB ZONE - A 1400.0 F

Change Trend View

Trend Length: 15

Compression Type: Avg

SOAK #1 123.4 MIN. ELAPSD TIME 225.8 MIN.

SOAK #2 74.5 MIN. QUENCH OIL 165.4 DEGF

Fig. 4. Trend view feature for changing time window and historical recall.

Trending Continued

hour, 8 hours, etc. Then the time window can be changed to obtain a longer or shorter term view of the process changes.

Trend graphs are easily configured using a standard trend template with a rotating data window (Fig. 5) which emulates MICROMAX trend screen features or a basic vertical or horizontal trend graph with only range windows. Trend plots can be easily sized in both directions to fit any part of a screen such as a tabular data screen or a loop or graphic screen. Point data is menu-selected along with trend color. The range of each data point trended (which may be different) is presented in the range windows at the top and bottom of the scale.

Trend data, running or historical, can be archived on-line to floppy disk in a normal format or a DIF format for off-line spreadsheet analysis. Trend files can also be restored to hard disk from floppy for historical review. Trend graphs can be started or stopped on event coincident with a batch or time and printed on demand.

Rotating data window

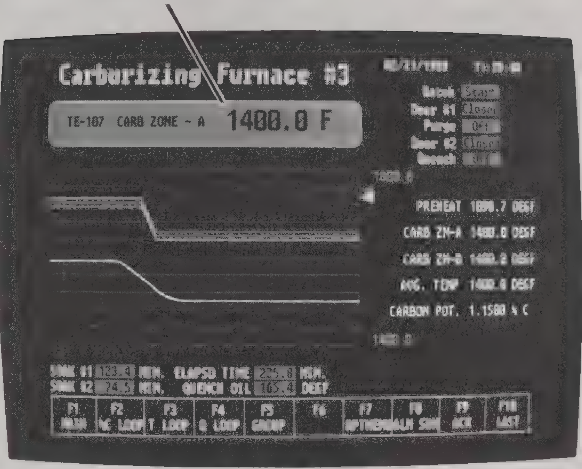

Carburizing Furnace #3
TE-107 CARB ZONE - A 1400.0 F
Start
Closed
OFF
Closed
PREHEAT 1800.7 DEGF
CARB ZN-A 1400.0 DEGF
CARB ZN-B 1400.2 DEGF
AVG. TEMP 1400.0 DEGF
CARBON POT. 1.1500 % C
ELAPSD TIME
QUENCH OIL 165.4 DEGF
F1
F2
F3
F4
F5
F6
F7
F8
F9
F10
T LOOP
GROUP

Fig. 5. Horizontal Trend.

Process Graphics

Graphics Features

- Hi-resolution, vector-based graphics (pixel resolution).
- Choice of 16 colors: interior of shape, exterior (text or shape borders).
- Choice of 37 "fill" patterns for interiors of shapes.
- Freeform placement of text, MICROMAX data, and shapes.
- Drawing of text (4 sizes), circles, ellipses, rectangles, lines (6 styles/selectable width), arrows, polygons, with border colors/widths.
- Use icon library or build your own, resize on screen or change attributes.
- Assignable "Hot Spots" to screen areas permit mouse/cursor operator interface for changing screens, menu selections, writing values, start/stop, changing I/O status, etc.
- Assignable function keys for operator interface development.
- Assignable "ENTER" fields anywhere on the screen, cursor/mouse selected, for text or parameter writes to LPUs.
- Grid snapping for ease of text and shape placement.
- Copy, move, size operations.
- Animation via color conditionals on analog I/O (7 levels) or discrete I/O status (2 levels), indicators (SP, alarms), blinking, sound (siren or beep), moving bar charts.
- IF-THEN-ELSE and math statements for special entry requirements and complex animation.

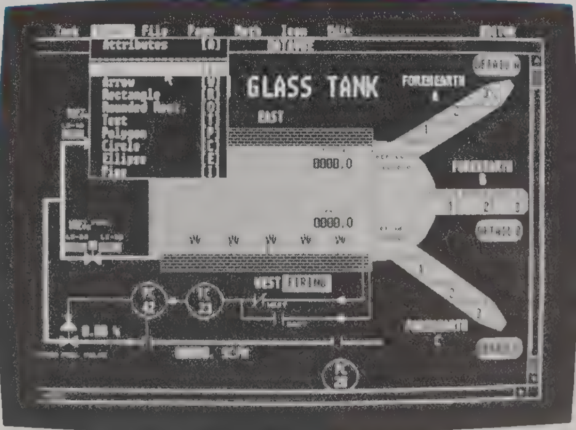

File
Attributes
Arrow
Rectangle
Rounded Rect.
Text
Polygon
Circle
Ellipse
GLASS TANK
FOREHEARTH A
EAST
0000.0
FOREHEARTH B
0000.0
FIRING
1
2
3

Fig. 6. Building a graphic screen.

Mouse-driven screen development, pull-down menus, windowed "dialog boxes", and advanced drawing tools available in DATAVUE speed the design of graphic screens (Fig. 6). Editing is enhanced with CAD-like features including moving and freely sizing of mouse-created shapes or standard icons such as valves or pumps obtained from a library. Any shape or combination of shapes along with their animation function, or even text, can be called an icon and stored in a library for recall and placement on any screen to simplify development. Icons can also be rotated in 90° increments for changes in direction. Similar shapes can be snapped to grid pattern along with text and data for precise positioning.

(Continued)

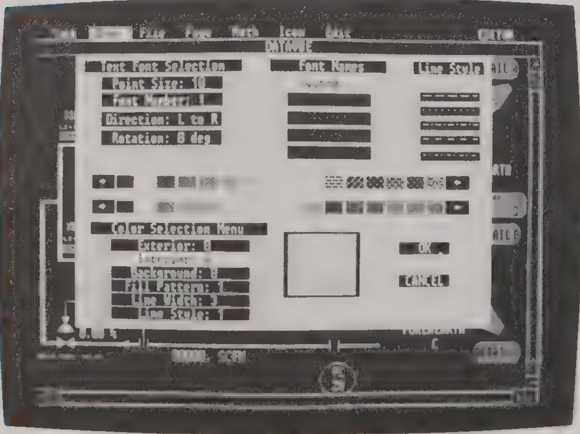
Process Graphics Continued

An Attributes window (Fig. 7) can be selected at any time to choose (or change existing) exterior and interior color, background color to identify operator entry fields, line width and style, text size and direction, or a "fill" pattern for shape interiors. Editing of actions applied to shapes or attribute changes are executed simply by selecting the editing function from a pull-down menu and pointing to the shape or function to be edited (Fig. 8). Sliders activated with a mouse or cursor are used to go off screen for creating or viewing expanded process area screens.

For process monitoring, a trend graph can be easily placed anywhere on the graphic screen (Fig. 9). Loop parameters such as process variable, setpoint and output could be viewed over a selected time span for process upset evaluation or loop tuning. A loop template icon placeable anywhere on the screen and assignable to any loop plus a preformatted loop detail screen (Fig. 10) are provided to simplify the control loop interface configuration.

Screen animation capability is extensive, and easy to configure. For example, any shape (such as a tank) may function as a bar graph with the level changing in a selected color and fill pattern based on a parameter value. The same tank interior color can be changed up to 7 different colors as the tank temperature changes. For normal bar graphs, indicators may be simply ranged and placed next to bars for setpoint indication or alarm levels. Color changes, including blinking, may be applied to any "pipe" or shape to show material flow or I/O status change. IF-THEN-ELSE statements which can combine simple math, logic, and compare functions are used for more extensive animation and multiple actions such as writing of parameter values for a recipe based on a recipe name or number; placing messages anywhere on the screen; moving, placing, or blanking graphic shapes, etc.

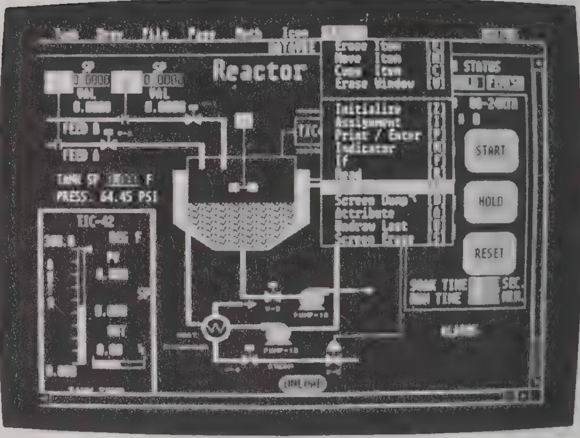
On-screen calculations can be utilized for calculating dynamic deviations, averages, or totals from one or more LPU's, represented as bar graphs on the screen, or simply displayed in numeric format with the desired field width.



File
Page
Math
Icon
Misc
Text Font Selection
Font Names
Line Style
Color Selection Menu
OK
CANCEL

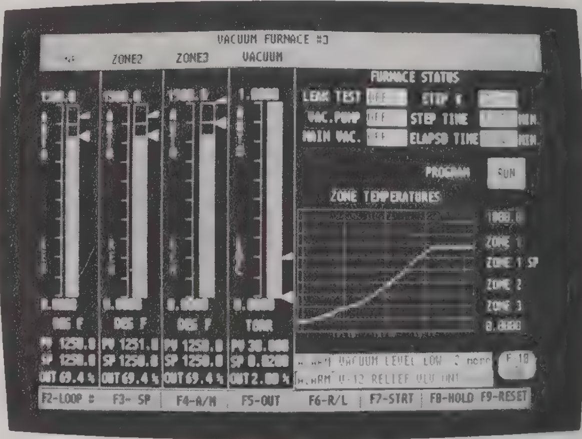
Point Size: 10
Font Number: 1
Direction: L to R
Rotation: 0 deg
Exterior: 0
Background: 0
Fill Pattern: 1
Line Width: 3
Line Style: 1

Fig. 7. Attributes window.



Reactor
Erase Item
Move Item
Copy Item
Erase Window
Initialize
Assignment
Print / Excer
Indicator
IF
Screen Dump
Attribute
Redraw Last
STATUS
START
HOLD
RESET
FEED B
FEED A
TANK SP
PRESS. 64.45 PSI
TIC-42
SP
VAL
SOAK TIME
RUN TIME
ALARMS

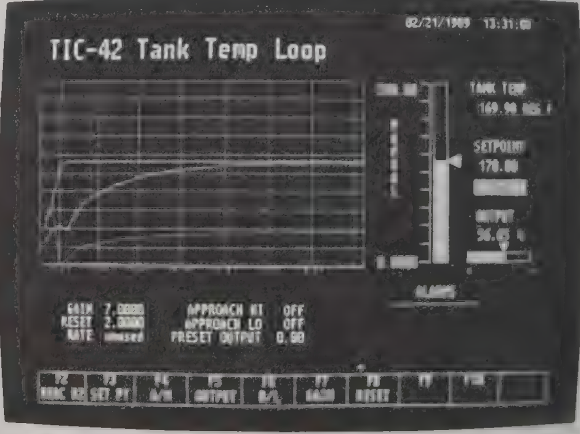
Fig. 8. Editing a graphic screen.



VACUUM FURNACE #3
ZONE2
ZONE3
VACUUM
FURNACE STATUS
LEAK TEST
VAC.PUMP
MAIN VAC.
STEP #
STEP TIME
ELAPSD TIME
MIN.
PROGRAM
RUN
ZONE TEMPERATURES
ZONE 1
ZONE 1 SP
ZONE 2
ZONE 3
DEG F
TORR
F2-LOOP #
F3- SP
F4-A/M
F5-OUT
F6-R/L
F7-STRT
F8-HOLD
F9-RESET

PV 1250.0 | PV 1251.0 | PV 1250.0 | PV 30.000
SP 1250.0 | SP 1250.0 | SP 1250.0 | SP 0.0200
OUT 69.4 % | OUT 69.4 % | OUT 69.4 % | OUT 2.00 %

Fig. 9. Vacuum furnace control screen with trending.



TIC-42 Tank Temp Loop
02/21/1989 13:31:00
TANK TEMP
SETPOINT
OUTPUT
ALARMS
F3 SET PT
F5 OUTPUT
F8 RESET

TANK TEMP 169.98 DEG F
SETPOINT 170.00
GAIN 7.0000
RESET 2.0000
RATE unused
APPROACH HI OFF
APPROACH LO OFF
PRESET OUTPUT 0.00

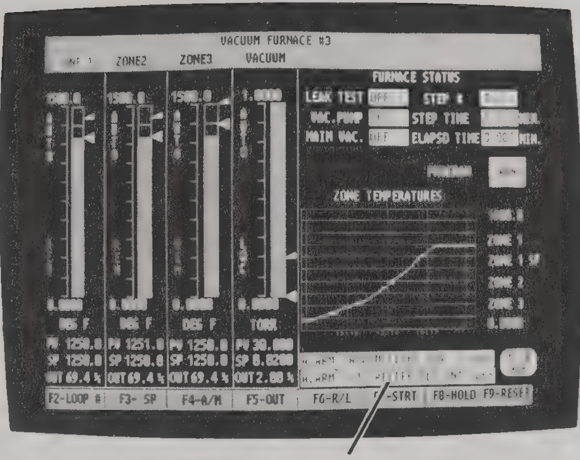
Fig. 10. Fixed template for a control loop detail screen.

Alarming

Alarms are created independent of the Management Station, applicable to any analog value or discrete I/O state. If an alarm occurs, a "target screen" can be defined for each alarm to change the display when acknowledged to one that is more critical to the alarm state. An alarm icon may be created and applied to any screen (Fig.11) which can blink to identify any new alarms and display an alarm message. The latest 2 active alarms with their messages can be displayed with the number of unacknowledged alarms also indicated. An alarm summary screen shows active alarms with the alarm message plus time and date of occurrence while an alarm history screen shows the date/time of alarm in/out.

Alarming Features:

- **Definable alarm icon applied to any screen.**
- **Assignable function key for Acknowledge.**
- **Preformatted alarm summary/history screens.**
- **Assignable "target" screens on Acknowledge.**


VACUUM FURNACE #3
ZONE2
ZONE3
VACUUM
FURNACE STATUS
LEAK TEST
STEP #
VAC.PUMP
STEP TIME
MAIN VAC.
ELAPSD TIME
MIN.
ZONE TEMPERATURES
DEG F
DEG F
DEG F
TORR
F2-LOOP #
F3- SP
F4-A/M
F5-OUT
F6-R/L
F8-HOLD
F9-RESET

User Configured Alarm "Icon"

Fig. 11. Alarm messages may be added to any graphic screen.

Operator Interface Development

Function keys F1 through F10 can have different or common assignments on each screen (Fig. 12) This allows you to customize the operator interface including screen heirarchy and interactive functions. For expanded requirements, an additional 20 function keys can be defined by using the Shift and Control keys. Key assignments for screen access include selection of specific screens, menu screens, windowed menu lists of pending, running, and historical reports or trends, or last screen. This enables an efficient screen heirarchy to be developed for your operators and supervisory personnel. Screens can also be called up automatically on event.

For supervisory control, the F-keys can be configured to bring up operator message prompts for selecting a loop and entering control setpoints, output levels, tuning constant values, or for entering individual batch parameters or a recipe with predefined parameters from the database (Fig. 13). The key prompt execution can also be configured to ask for a security code prior to entry. Batches can be started or stopped, setpoint programs put in hold or reset, loops put in auto/manual or remote/local sepoint mode, pumps or solenoid valves turned off/on, alarms acknowledged, etc. by configuring F-key operations accordingly.

(Continued)

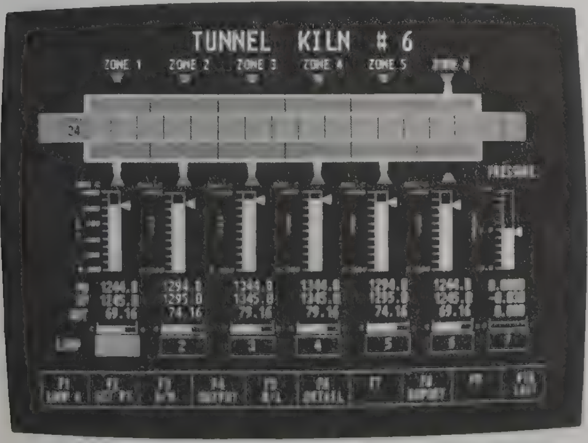

TUNNEL KILN # 6
ZONE 1
ZONE 2
ZONE 3
ZONE 4
ZONE 5
PRESSURE

Fig. 12. Operator interface with definable function keys.

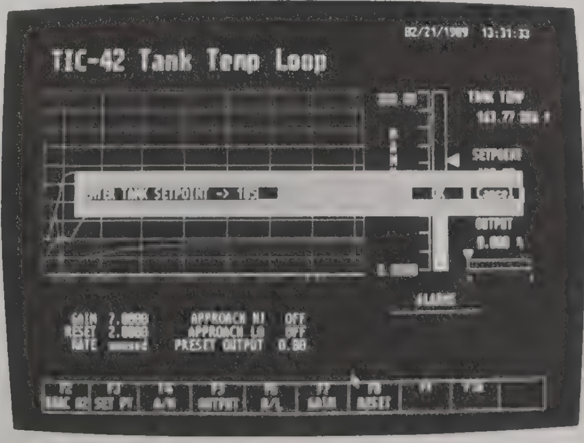

02/21/1989 13:31:33
TIC-42 Tank Temp Loop
TANK TEMP
SETPOINT
OUTPUT
ALARM
GAIN 7.0000
RESET 2.0000
RATE
APPROACH HI OFF
APPROACH LO OFF
PRESET OUTPUT 0.00

Fig. 13. Key prompts are easily defined for operator entry of setpoints, recipes, etc.

Operator Interface Development Continued

Hot spots are defined to be any portion of a screen (around a "button" or shape, for example) that is responsive to cursor or mouse "clicking" to cause actions the same as those defined for function keys (Fig. 14). For example, you can "click on" a Start "button" directly to start a process or position the cursor on a pump to force it on or off. The mouse or cursor may also be used to "click on" ENTER fields placed anywhere on the screen where a numeric entry can be made to write a value to the LPU.

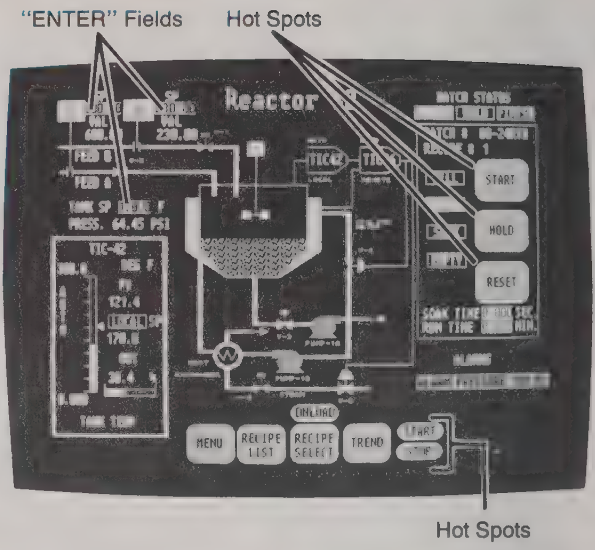


Fig. 14. Operator interface showing Hot Spots and ENTER fields.

Specifications

Package options: Reports/Trends only (no graphics drawing except rectangles) or Reports/Trends/Graphics.
MICROMAX Data Access: Essentially all MICROMAX data is accessible for read to the screens. Available write parameters: Discrete I/O (force); loop local/remote setpoints, A/M, R/L, output, tuning constants, setpoint programmer start, hold, advance, reset; constant values.
Data communications: 300 – 19.2K Baud, asynchronous, RS-422/485
No. of LPU's addressable on network: 32
Max. distance: 2500 ft. (assumes use of recommended Belden 8728 cable or equivalent, routing in conduit or in low power cable tray, and recommended interface hardware).
No. of graphic screens: Disk-limited (5-15K bytes/screen type)
No. of parameters/screen: 75
Screen update rate: selectable, 2 seconds, typical

Hardware: IBM PS/2 Model 30 286, Model 50 and above, "AT" Computers, Compaq Deskpro 286, or 386S (386S recommended for graphics applications); with the following requirements:

- 1 MB RAM memory.
- 20 MB hard disk min., more for extensive historical data.
- 1 or more floppy drives (3½", 1.44 MB or 5¼", 1.2 MB HD).
- EGA or VGA graphics board.
- RS-422 direct (not on PS/2 Series) or RS-232 serial port. (RS-232 serial port requires RS-422/232 converter).
- EGA (640x350 pixels) or VGA (640x480 pixels) monitor.

(Note: L&N guarantees performance on these computers only.)
Operating System: DOS 2.0 and above (computer dependent).
Mouse (serial board required if not direct input).

Options:
Epson FX wide carriage printers, IBM Proprinter. Graphics printout requires additional 3 MB RAM Memory.

The following trademarks appear in this publication: IBM, IBM Corp.; LOTUS 1-2-3, Lotus Development Corp.; COMPAQ and DESKPRO, Compaq Computer Corp.; MICROMAX®, Leeds & Northrup, A Unit of General Signal. DATAVUE™, also a trademark of Leeds & Northrup, identifies a copyrighted computer software product of UFO Systems, Inc., developed for Leeds & Northrup.

For a detailed description of MICROMAX Process Management Systems, see L&N Publication GO.0001-DB

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A UNIT OF GENERAL SIGNAL

Instrument and System Solutions!

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L&N 2600-Series High Performance Transmitters for Differential, Absolute and Gage Pressure, Flow and Liquid Level

Electronic
Pressure
Transmitters

D4.2601-DS

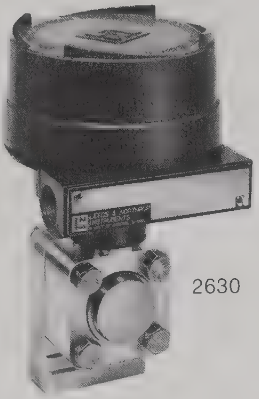
- **Extreme accuracy <±0.1% typical/±0.2% max. Certified 0.1% accuracy available.**
- **Rangeability up to 9:1 without degradation in temperature and static pressure performance.**
- **Wide turndown—up to 10:1**
- **Industry's broadest range of spans—0.2″ W.C. to 5000 psi**
- **Unmatched long life amplifier design—400,000 hours calculated MTBF**
- **Hastelloy C-276 diaphragms, standard; full choice of optional wetted materials**
- **External zero, span and damping adjustments**
- **Widest power supply operating range—13-48 V dc**
- **Virtual immunity to RFI**
- **Compact and lightweight**
- **Supported by a full range of options**
- **Field calibratable using the 0.1% accurate LCD meter option**

The L&N 2600-Series Transmitters are designed to deliver exceptional performance and high accuracy despite adverse process and environmental conditions, with an MTBF of 400,000 hours @ 70°C.

The sensing capsule uses an ultra-stable differential-capacitance detection technique for measurement accuracy and reliability.

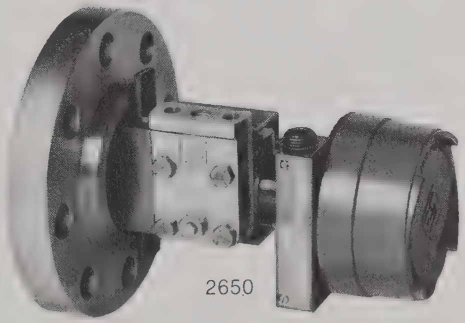
Spans have a rangeability adjustment of up to 9:1. L&N defines rangeability as turndown without introducing additional error due to temperature or static pressure effects. This unique rangeability feature permits turndown to a specific range with a resolution ideally suited to the application.

A variety of wetted materials is available for the diaphragms and flanges, providing a choice of combinations to match application requirements. Flanges, with ¼″ NPT inlet connections, can be rotated to permit sure connections at either side, or bottom; optional flange adapters, of the specified flange material, provide ½″ NPT connections. For liquid-level applications, an integral 3″ or 4″ flange, rated at 150 or 300 lb, and featuring either a flush or extended diaphragm, can be mounted directed against the side of a tank or vessel.



2630

2610



2650

Linear or square-root output is 4 to 20 mA (10 to 50 mA, 0-40 mA or 0-16 mA optional). As two-wire transmitters energized by a 24 V dc supply, these units are FM Entity-Approved for Class 1, II & III, Division 1, Groups A to G locations, when used with L&N or other approved Intrinsic Safety Barriers.

Additionally, the transmitters can operate on a dc power supply from 13 to 48 V. For 120 V 50/60 Hz operation (four-wire system), a power supply is mounted in a separate close coupled housing. Lightning and transient overvoltage surge protection can be provided in the same separate, close coupled housing.

Where on-site indication of transmitter output is desired, an optional analog (deflection) meter or 0.1% accurate LCD display can be mounted integral with the transmitter. The analog meter can also be remotely located, in a separate housing.

Compact and lightweight, these transmitters can be equipped with a universal bracket for wall- or pipe-mounting, adaptable to virtually any process installation.

LEEDS & NORTHRUP
A UNIT OF GENERAL SIGNAL

Instrument & System Solutions!

Catalog Number			2610 Differential Pressure & 2620 Flow		2630 Gage Pressure		2640 Absolute Pressure		2650 Liquid Level	
INPUT	Spans (Min./Max.)		**Capsule Spans** 2″/1″ W.C. 1″/6″ W.C. 3″/30″ W.C. 15″/150″ W.C. 45″/450″ W.C. 200″/2000″ W.C. 1000″/6200″ W.C.	**Rangeability** .2″/1″ W.C. 1″/6″ W.C. 5″/30″ W.C. 25″/150″ W.C. 75″/450″ W.C. 325″/2000″ W.C. 3000″/6200″ W C	**Capsule Spans** 3″/30″ W.C. 15″/150″ W.C. 45″/450″ W.C. 200″/2000″ W.C. 1000″/8000″ W.C. 250/1000 psi 800/3200 psi 1500/5000 psi	**Rangeability** 5″/30″ W.C. 20″/150″ W.C. 50″/450″ W.C. 325″/2000″ W.C. 2000″/8000″ W C 250/1000 ps 800/3200 psi 1500/6000 psi	**Capsule Spans** 15″/150″ W.C.A. 45″/450″ W.C.A. 200″/2000″ W.C.A. 1000″/8000″ W.C.A.	**Rangeability** 20″/150″ W.C.A. 50″/450″ W.C.A. 325″/2000″ W.C.A 2000″/8000″ W C A	**Capsule Spans** 15″/150″ W.C 45″/450″ W.C. 200″/2000″ W.C 1000″/6200″ W.C	**Rangeability** 25″/150″ W.C 75″/450″ W C 325″/2000″ W C 2000″/6200″ W C
	Zero Adjustment		Zero adjustment is provided by a potentiometer in combination with a four position jumper. The jumper position selected provides a zero suppression or elevation adjustability of either −4 to +4%, −10 to +10%, −40 to +40% or −100 to +100% of maximum capsule span Upper range limit must not exceed maximum capsule span value							
OUTPUT	**Standard**		4-20 mA d c into 0 to 550 ohms, operating on 24 V d c two-wire supply. (A 1850-ohm load resistance can be accommodated by increasing the supply voltage to 48 V d c, maximum.) Signal is linear with pressure (2610, 2630, 2640 or 2650) or with the square root of the differential pressure (2620).							
	Optional		Reverse-acting output (increasing output signal with decreasing input), a 10-50 mA, 0-40 mA or 0-16 mA output can be provided							
	Optional Output Meter		An analog output meter with a 0-100 linear and a 0-10 square-root calibration on the same scale, can be internally or remotely mounted. A 0.1% accurate LCD output meter with linear digital display can be internally mounted Special scales available							
PERFORMANCE*	**Accuracy**		< ± 0.1% of calibrated span typical/ ± 0.2% max. Includes combined effects of linearity, hysteresis and repeatability.							
	Deadband		None							
	Damping		Electronic; time constant continuously adjustable between 0.2 and 8.0 seconds							
	Drift		Ranges 100, 101, and 102 — 0.5% of upper range limit six months. Ranges 103 through 109 — 0.2% of upper range limit six months.							
	Static Pressure or Overrange Limit		**Span Max.** / **Static Pressure or Overrange Limit** 1″ 300 psig 6″ 300 psig 30″ 300 psig 150″ 2000 psig (5000 psig optional) 450″ 2000 psig (5000 psig optional) 2000″ 2000 psig 6200″ 2000 psig Note Operates from full vacuum to static pressure Operates within specifications from 0.5 psia static pressure		**Span Max.** / **Overrange Limit** 30″ W C 1400″ W C 150″ W.C. 2200″ W.C. 450″ W.C. 3600″ W.C. 2000″ W.C. 5000″ W.C. 8000″ W.C. 12000″ W.C. 1000 psig 2000 psi 3200 psig 6000 psi 5000 psig 6000 psi Note: Will withstand full vacuum but on spec performance guaranteed only from 0.5 psia.		**Span Max.** / **Overrange Limit** 150″ W.C.A. 2200″ W.C.A. 450″ W.C.A. 3600″ W.C.A. 2000″ W.C.A. 5000″ W.C.A. 8000″ W.C A. 12000″ W.C.A.		**Static Pressure Limit:** To the flange rating. At 38 C (100 F), 150-lb flange is rated from full vacuum to 275 psig, 300-lb flange from full vacuum to 720 psig. Note: Operation within specifications from 0.5 psia static pressure.	
OPERATING INFLUENCES †	**Temperature Effect**		On zero and span, for a 56 C (100 F) change over the range of +4 to +60 C (+40 to 140 F). See appropriate data sheet.							
	Temperature Limits	**Operating**	−35 to +82 C (−30 to +180 F) for electronics housing. −35 to +121 C (−30 to +250 F) at barrier diaphragm(s).							
		Storage	−35 to +93 C (−30 to +200 F)							
	Relative Humidity Limits		Fully operable over the range of 0 to 100% R.H.							
	Load Resistance Effect		Less than 0.25% maximum output shift, for a 0 to 550-ohm change.							
	Power Supply Effect		Less than 0.01% per volt change, over the full operating voltage range (13 V minimum, 48 V maximum).							

*Per ISA S51.1 (1976), at reference conditions: 25 C ambient temperature. 40% R.H., fixed 24 V d c line voltage, zero static pressure and zero vibration

†Zero-based spans, Hastelloy C-276 Diaphragms, D-C 200 oil fill

Leeds & Northrup

CATALOG NUMBER		2610 Differential Pressure & 2620 Flow	2630 Gage Pressure	2640 Absolute Pressure	2650 Liquid Level
OPERATING INFLUENCES (Continued)	Radio Frequency Interference	Less than 0.15% maximum output shift at a distance of 3 ft. (.9 m) from a 5W transmitter at 20-30, 150-160 and 450-460 MHz			
	Mounting Position	No effect on span. Zero shift can be calibrated out.			
	Static Pressure or Overpressure Effect	**Static Pressure Effect:** **Upper Range Limit** / **On Zero** / **On Span** 1" W C / ±.008"/100 psig / ±1%/100 psig 6" W C / ±.01"/100 psig / ±0.25%/100 psig 30" W.C. / ±.048"/100 psig / ±0.25%/100 psig 150" W.C. / ±.060"/2000 psig / ±1%/2000 psig 450" W.C. / ±.180"/2000 psig / ±1%/2000 psig 2000" W.C. / ±.800"/2000 psig / ±1%/2000 psig 6200" W.C. / ±2 480"/2000 psig / ±1%/2000 psig Overpressure ** Effect on Zero or Span 2610 Differential Pressure. 0.25%/2000 psi except 0.02" W.C /100 psi for ranges 100, 101, 102 2620 Flow: Zero Effect = 0.50%/2000 psi except 0.04" W.C./100 psi for ranges 100, 101, 102 Span Effect = Same as 2610	Overpressure Effect: ±0.25% of upper range limit for overpressure (overrange limit listed above).	Overpressure Effect. ±0.25% of upper range limit for overpressure (overrange limit listed above).	**Static Pressure Effect:** **Range** / **Span or Zero Shift (% of Cal. Span)** 103 / 1%/100 psig 104 / 0.5%/100 psig 105 / 0.2%/100 psig 106 / 0.2%/100 psig
	Vibration Effect	Operates at 5-15 Hz (4 mm uniform displacement) 15-150 Hz (2g), 150-500 Hz (1g) in all three axes			
POWER REQUIREMENTS	Standard	24 V d c supply, two-wire, for 0 to 550-ohm load. (Up to 48 V d c maximum, for 0 to 1850-ohm load: 13 V d c, minimum.)			
	Optional	Power supply assembly in separate housing close-coupled to transmitter housing, operating on 120 V, 50/60 Hz, 3.0 VA. Four-wire system. Operating temperature range, −35 C to +82 C (−30 to +180 F). Operating effects on transmitter output, ±10% change in 120 V a c supply causes less than ±0.02% shift, temperature effect, no more than 0.04% additional to those listed under "Operating Influences": output noise, 0 3% from 50 to 10K Hz			
	Intrinsic Safety	Transmitter is FM entity approved for intrinsically safe loops (24 VDC two-wire operation only) in Class I, II, III, Division 1, Groups A through G hazardous locations when used with L&N 316569 (or other approved) Intrinsic Safety Barrier per Drawing C-ID-100160 Entity Paramaters. V_{max} = 36.1 V, I_{max} = 105 mA, C_i = 0 0μF, L_i = 0 5 mH			
	Nonincendive Classification	Transmitter is FM approved as nonincendive for Class I, II, III, Div 2, Groups A, B, C, D, F, G Hazardous Locations Dust resistivity ≥100,000 ohms/cm			
CONSTRUCTION	Sensing Unit	Standard Capsule barrier diaphragm is Hastelloy C-276. Monel, Tantalum, Carpenter 20 or Alloy 286 are optional. Standard flanges and adapters are nickel-plated carbon steel with 316 SS drain or vent valves. Hastelloy C, 316 SS, Monel, Carpenter 20 or Kynar plastic flanges, drain or vent valves are available as options. (Kynar flanges are rated at 300 psig at 80 F, 125 psig at 150 F.) O-rings are Viton A (Teflon optional). Flange bolts are zinc-plated steel (316 SS optional).			Diaphragm is Hastelloy C-276; diaphragm extension (2", 4" or 6"), 316 SS. Low-pressure and mounting flanges are nickel-plated carbon steel or 316 SS Mounting flanges can be 3" or 4", rated at 150 or 300 lb
	Fill Fluid	Dow Corning silicone oil. Fluorolube Fill optional (not for vacuum service).		Dow Corning silicone oil.	
	Volumetric Displacement	Less than 0.004 cu. in. (0.065 ml)			
	Electronics Housing	Explosion and dust ignition proof housing FM approved for Class I Division 1 Groups B C D Class II Division 1 Groups E F G suitable for Class III Division 1 hazardous locations NEMA 4 cast low copper-aluminum alloy waterproof design fully anodized and coated with aliphatic urethane finish			
	Terminations	Internal terminal board. Potted nipple with 3 ft. leads is optional			
	Mounting	Optional wall- or pipe-mounting bracket, nickel-plated steel.			Mounting flange mounts directly on side of tank or vessel
	Dimensions	8.312 in. (h.) by 4.625 in. (dia.) — 211.12 mm (h) by 177.48 mm (dia.)			
	Weight	8.5 lbs (3.8 kg)	7 lbs. (3.2 kg)		With 150 lb. flange 3", 7.5 Kg (16.5 lbs.). 4", 9.8 Kg (21 5 lbs.) With 300 lb flange 3", 8.9 Kg (19.5 lbs.): 4", 14.3 Kg (31 5 lbs.)

** Overpressure is repeated application of pressure to one side only.

Because Leeds & Northrup endeavors to continuously improve the value of its products all specifications are subject to change without notice

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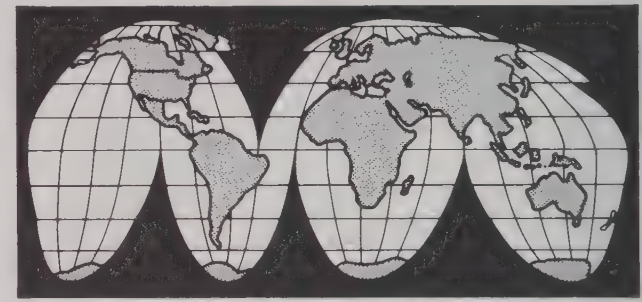

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Electrolytic Conductivity

D2.2141-DS

7079-17 Electrolytic Conductivity Transmitter

- **True two-wire transmitter system, to reduce wiring and installation costs; four wire operation available**
- **Isolated 4-20 mA output, proportional to selected conductivity range**
- **Digital readout (LCD), highly visible even in direct sunlight**
- **Switch-selectable ranges, from 0-0.5 to 0-500,000 micromhos/cm (microsiemens/cm), or equivalent microsiemens/m or millisiemens/m; 0-100 ohms-cm to 0-20 megohms-cm; or percent concentration**
- **Built-in check switch for calibration**
- **Automatic or fixed temperature compensation**
- **FM approved Intrinsically Safe for Class I, Division 1, Group A, B, C and D requirements with appropriate L&N barriers**
- **FM approved Explosion Proof for Class I, Division 1, Groups C & D**
- **Plug-in printed-circuit boards for easy servicing**
- **Noryl corrosion-resistant plastic case, NEMA 4X design, suitable for outdoor mounting, with internal conductive coating for effective EMI shielding; or**
- **Cast-aluminum case, NEMA 4 waterproof design for outdoor and explosion-proof installation**
- **Optional external alarm/control modules to provide on/off control**

100.0
micromhos/cm
(microsiemens/cm)
SPECIFIC
CONDUCTANCE

7079-17 Transmitter in Noryl Plastic Case

The L&N 7079-17 Electrolytic Conductivity Transmitter is designed to meet the need—especially in the chemical process industry, and power generation—for an inexpensive two-wire transmitter which produces a current output signal proportional to the selected range (conductance or resistance), with the option of intrinsically safe or explosion-proof operation.

The Transmitter provides a 4-20 mA output signal compatible with MAX™ 1 Distributed Control, Centry® and other process-control systems. Range is displayed on the 3½-digit, seven segment liquid-crystal display. One model provides all ranges; switch-selection of basic ranges, plus switch-selection of multipliers—from X0.01 to X100—and the choice of appropriate cell constants assure maximum versatility of application.

For conductance measurements, ranges are expressed in micromhos/cm, microsiemens/cm. (Microsiemens/cm can be converted to microsiemens/m by multiplying by 100; to millisiemens/m, by multiplying by 0.1; to siemens/m, multiplying by 10^{-4}). For resistance measurements, ranges are expressed in ohms-cm or megohms-cm. For percent concentration measurements, a 0-100 digital range corresponds to the non-linear percentage range (e.g., 0-6% NaOH); a conversion table provides the equivalent percentage value for a digital readout.

Either the metal NEMA 4 or plastic NEMA 4X housing can be used for intrinsically safe loops (24 V two-wire operation) with separately ordered L&N intrinsic safety barriers. The cast aluminum case is explosion proof for Class I, Division 1, Group C and D locations when installed with potted external conduit connections.

The Transmitter receives its 24 V dc supply from an external source. As an alternative, it can be provided with an integral power supply within the case, operating on 120 V, 50-60 Hz (four-wire system).

To provide simple but effective on-off control, a 7080 Alarm/Control Module, with up to 4 plug-in high and/or low alarm/control relays, may be connected to the output circuit of the Transmitter.

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SPECIFICATIONS

Ranges Selectable. Conductance: 0-1, 0-10, 0-100, etc. to 0-100,000, or 0-2, 0-20, 0-200, etc. to 0-200,000, or 0-0.5, 0-5, 0-50, etc. to 500,000 micromhos/cm (microsiemens/cm), or equivalents in microsiemens/m or millisiemens/m. Resistance: 0-100, 0-1K, etc. to 0-10M, or 0-200, 0-2K, etc. to 0-20M ohms-cm. Concentration: 0-6% NaOH and 0-12% H_2SO_4, by conversion table.

Display Conductance: 0-500, 0-1000 or 0-2000, switch-selected, with switch-selected multipliers, X1, X10 or X100. Resistance: 0-1000 or 0-2000, switch-selected, with switch-selected multipliers, X1, X0.1 or X0.01. Concentration: 0-100.0, corresponding to non-linear percentage span; conversion table provided.

LCD Readout Integrally mounted in case. Highly visible liquid-crystal display, 3½ digit (1999 maximum), with ½-inch numerals. Resolution (1 count) depends on range, multiplier and cell constant selected.

Output 4-20 mA dc into 500-ohm (maximum) load, operating on 24 V dc two-wire supply. Input/output isolation, 30 V ac or 60 V dc max.

Function Switch Measure/Check switch in terminal compartment provides (1) cell measurement or (2) measurement of internal precision resistor (±0.25% accuracy) for a calibration check.

Measuring Frequency 80 Hz or 640 Hz, switch-selected. The higher frequency is used for low resistance (high conductance) ranges to reduce the polarization of the electrodes.

Performance Under reference operating conditions.

Display Accuracy: ±0.5% of full scale ±1 count.

Current-Output Accuracy: ±0.5% of full scale.

Range Multiplier: ±0.3% of selected range.

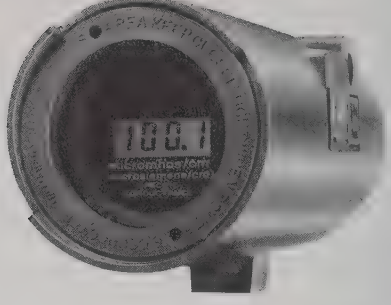
Reproducibility: ±0.2% of full scale, over 1 month.

Linearity: ±0.4% of full scale.

Response Time: Display updated once each second. Current output, 3 seconds for 90% of a step-change.

Reference Operating Conditions: Ambient temperature, 25 C (77 F); Relative Humidity, less than 50%; Line Voltage, 24 V d-c; no vibration, no EMI.

Ambient Temperature Limits 0 to 70 C (32 to 158 F) for rated accuracy; −40 to 80 C (−40 to 176 F) for storage.


100.1
micromhos/cm

7079-17 Transmitter in Metal Case

Relative Humidity Limits 95% max., non-condensing, at 40 C (104 F), except for highest conductance and resistance ranges (90%, max.).

Operating Influences (under reference operating conditions)

Temperature: On zero, ±0.02% of span/°C, max. On span, ±0.02% of span/°C, max.

Voltage: ±0.01% of span per 1% change in 24 V dc supply.

Relative Humidity: ±2% of span over 0-95% R.H. (or 90% R.H., for highest ranges).

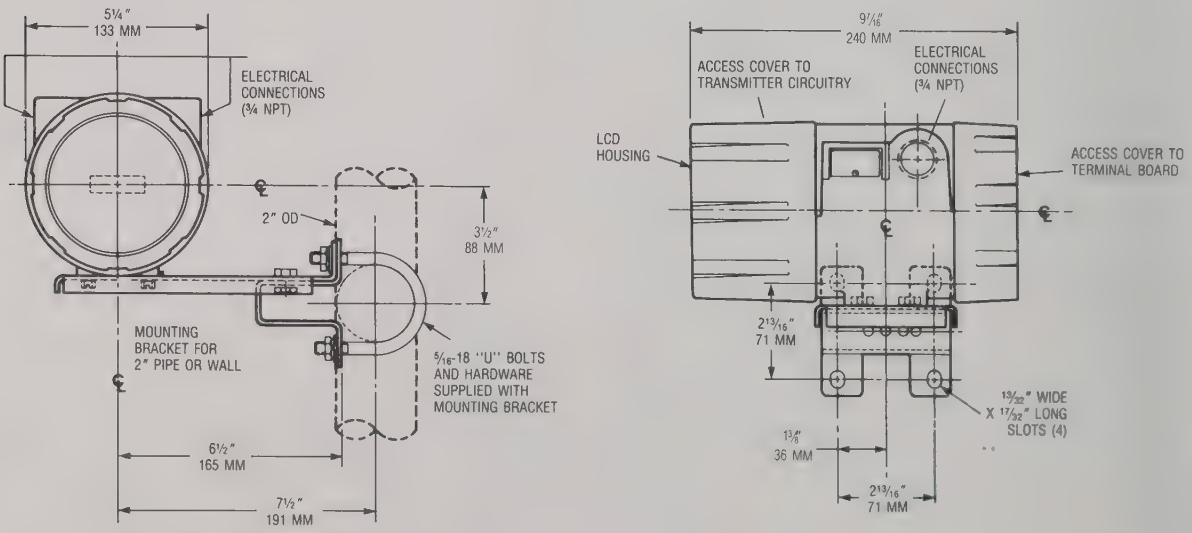
Optional Alarming A separately ordered 7080 Alarm/Control Module, housing one or two plug-in high and/or low alarm/control relays, can be connected to the Transmitter output to provide on-off control or alarming. (Since the Module presents a full 500-ohm load to the Transmitter, any additional load would require a supply greater than 24 V dc.)

Power Requirements 24 V dc supply, two-wire, for 500-ohm (maximum) load.

Optional: Integrally mounted power supply operating on 120 V (108-132 V), 50-60 Hz (47-63 Hz). Maximum load, 500 ohms. Power consumption, 1.6 VA. Over-voltage protection is provided by a 130 V metal-oxide varistor.

Case (1) Noryl plastic corrosion-resistant case, NEMA 4X, with internal conductive coating to provide effective EMI shielding; suitable for outdoor mounting.

(2) Cast-aluminum case, NEMA 4 waterproof design, with urethane polyester finish. Explosion-proof for Class I,


5¼"
133 MM
ELECTRICAL CONNECTIONS (¾ NPT)
℄
2" OD
3½"
88 MM
MOUNTING BRACKET FOR 2" PIPE OR WALL
℄
5/16-18 "U" BOLTS AND HARDWARE SUPPLIED WITH MOUNTING BRACKET
6½"
165 MM
7½"
191 MM
9 7/16"
240 MM
ACCESS COVER TO TRANSMITTER CIRCUITRY
ELECTRICAL CONNECTIONS (¾ NPT)
LCD HOUSING
ACCESS COVER TO TERMINAL BOARD
℄
℄
2 13/16"
71 MM
13/32" WIDE X 17/32" LONG SLOTS (4)
1 3/8"
36 MM
2 13/16"
71 MM

TRANSMITTER DIMENSIONS—PLASTIC CASE

Division 1, Group C and D locations with separately ordered 025858 Potting Kits, for potting conduit connections. (FM approved).

Intrinsic Safety Transmitters can be used for intrinsically safe loops (24 V two-wire operation only) with separately ordered intrinsic safety barriers in Class I, Division 1, Group A, B, C and D locations (FM approved).

Terminations Plastic Case-two ¾" NPT conduit connections for power supply and cell cable; Metal Case: three ½" NPT conduit connections for power supply and cell cable.

Mounting Plastic Case-metal bracket for wall or pipe mounting is supplied loose; Metal Case: metal bracket is mounted on case.

Dimensions Plastic case: 5¼" OD × 9½" (133 × 241 mm). Metal case: With 24 V dc supply, 4¾" OD × 9" (120 × 228 mm); with integral 120 V ac supply, 4¾" OD × 10½" (120 × 267 mm).

Weight Noryl plastic case; approximately 4½ lb (2 kg). Cast-aluminum case: approximately 16 lb (7.3 kg).

HOW TO ORDER

Specify appropriate suffixes to complete the catalog number.

A B C D E
7079-17-☐☐-300-☐☐☐-☐☐☐

Suffix A. Type of Measurement

Conductance/Resistance/Concentration **17**

Suffix B. Housing

Description	Suffix
NEMA 4 heavy-duty waterproof cast-aluminum case*†	01
NEMA 4X Noryl plastic case*	03

Suffix C. Range

Internally Switch-selectable Ranges **300**
(See "Preferred Range and Cell Data" table, back page)

Suffix D. Power Supply

Description	Suffix
24 V D-C (Two-Wire System)	024
120 V, 50-60 Hz (Four-Wire System)	120

Suffix E. Tagging

Description	Suffix
None	000
1 Linen Tag, 23 Characters Max. on Each of Six Lines (Specify Legend)	206
1 Aluminum Tag, 15 Characters Max. on One Line (Specify Legend)	207
1 Stainless Steel Tag, 25 Characters Max. on Each of Three Lines (Specify Legend)	208
Same as "208", but permanently mounted on Transmitter	209

ACCESSORIES

FOR INTRINSICALLY SAFE OPERATION

316569 Positive Intrinsic Safety Barrier For negative-ground systems; two required

316747 Negative Intrinsic Safety Barrier For positive-ground systems (e.g., Centry process control); 2 required

FOR EXPLOSION-PROOFING (METAL CASE ONLY)

025858 Potting "Y" Kit Includes ½" NPT and ¾" NPT fitting, fiber filling material and potting compound (2 required)

FOR POWER-SUPPLY CONVERSION

Metal Case (One Each Required):

051924 Internal Power Supply Kit Converts 24 V dc two-wire Transmitter to 120 V ac four-wire Transmitter

022324 End-Cover Replaces existing cover

Plastic Case:

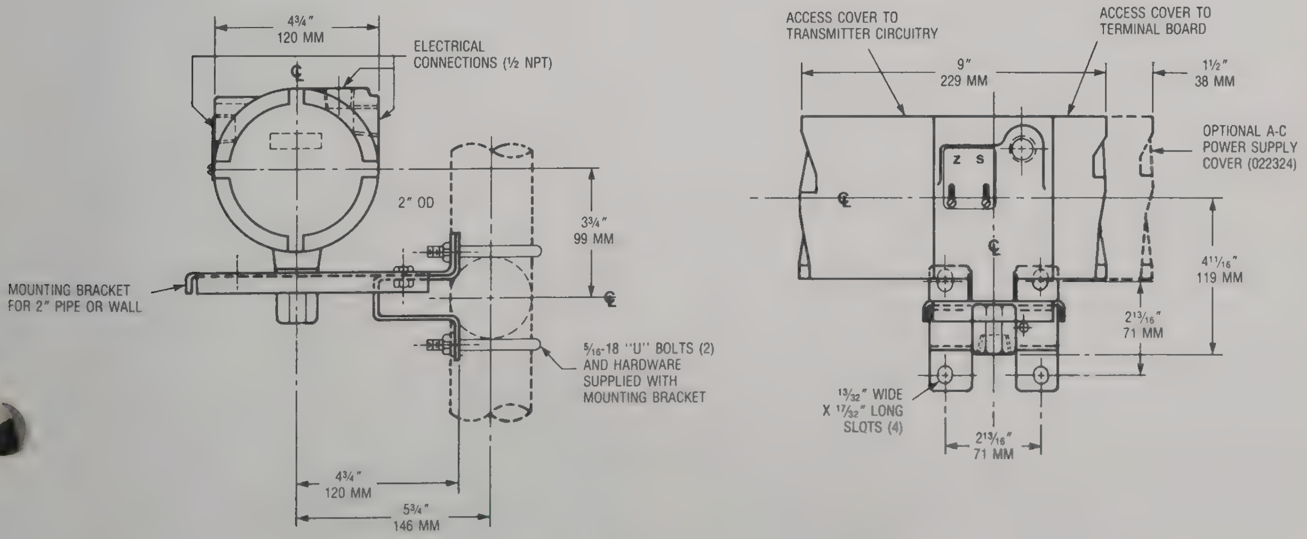
051925 Internal Power Supply Kit (New End-Cover not required)

FOR ALARM/CONTROL FUNCTIONS

7080 Alarm Module (See Data Sheet C12.1390-DS)

** FM approved intrinsically safe for Class I, Division 1, Groups A, B, C and D when used with L&N Intrinsic Safety Barriers (for 24 V dc operation only).*

†To make explosion-proof for Class I, Division 1, Groups C and D (FM approved), order (2) 025858 Potting Kits for external circuit connections. This will not assure an explosion-proof system, since explosion-proof cell housings are not available; for maximum safety, intrinsically safe systems with barriers are recommended—even where the Transmitter has been explosion-proofed.



4¾"
120 MM
ELECTRICAL
CONNECTIONS (½ NPT)
℄
2" OD
3¾"
99 MM
℄
MOUNTING BRACKET
FOR 2" PIPE OR WALL
5⁄16-18 "U" BOLTS (2)
AND HARDWARE
SUPPLIED WITH
MOUNTING BRACKET
4¾"
120 MM
5¾"
146 MM
ACCESS COVER TO
TRANSMITTER CIRCUITRY
ACCESS COVER TO
TERMINAL BOARD
9"
229 MM
1½"
38 MM
OPTIONAL A-C
POWER SUPPLY
COVER (022324)
Z S
℄
℄
4¹¹⁄₁₆"
119 MM
2¹³⁄₁₆"
71 MM
¹³⁄₃₂" WIDE
X ¹⁷⁄₃₂" LONG
SLOTS (4)
2¹³⁄₁₆"
71 MM

TRANSMITTER DIMENSIONS—METAL CASE

Preferred Range and Cell Data (some ranges can be obtained using other cell constants — see directions)

Transmitter Range		Cell Constant	Automatic Temperature Compensator					Fixed Temperature Compensator	
			Reference Conductivity at 25 C	4973 Cells		4800, 4905, 4909 Cells			
				Range Suffix*	Temperature Range	Range Suffix*	Temperature Range	Ohms at 25 C	Part Number**
CONDUCTIVITY, μMHOS/CM (or Equivalent Units)	0-1†	0.01	0.1 0.5	301 303	0-100 C	168 013	0-100 C 0-50 C	350 350	411741 411741
	0-10	0.01	0.5 5	303 305	0-100 C	013 009	0-50 C 0-100 C	350	411741
	0-100 0-1000 0-10,000 0-100,000	0.1 1 10 10	50 500 5000 50,000	305	0-100 C	009	0-100 C	350	411741
	0-2†	0.01	0.1 0.5	301 303	0-100 C	168 013	0-100 C 0-50 C	350 350	411741 411741
	0-20	0.01	0.5 10	303 305	0-100 C	013 009	0-50 C 0-100 C	350	411741
	0-200 0-2000 0-20,000	0.1 1 10	100 1000 10,000	305	0-100 C	009	0-100 C	350	411741
	0-200,000	20	100,000	—	—	009	0-100 C	350	411741
	0-0.5†	0.01	0.1 0.5	301 303	0-100 C	168 013	0-100 C 0-50 C	350 350	411741 411741
	0-5	0.01	0.5 2.5	303 305	0-100 C	013 009	0-50 C 0-100 C	350	411741
	0-50 0-500 0-5000 0-50,000	0.1 1 10 10	25 250 2500 25,000	305	0-100 C	009	0-100 C	350	411741
	0-500,000	50	250,000	—	—	009	0-100 C	350	411741
RESISTIVITY, OHMS-CM	0-20M†	0.01	16.6M	—		—	—	8000	411456
			10M 2M 0.5M	302 304 306	0-100 C	070 014 071	0-60 C	8000	411456
	0-10M†	0.01	10M 2M 0.5M	302 304 306	0-100 C	070 014 071	0-60 C	8000	411456
	0-2M	0.01	2M 0.5M	304 306		014 071			
	0-1M	0.01	0.5M	306		071			
	0-200K	0.01	100K	306		071			
	0-100K	1	50K	306		071			
	0-20K 0-10K	1 1	10K 5K	306		072			
	0-2K 0-1K	1	1K 500	306		072			
	0-200 0-100	10	100 50	306		072			
CONCENTRATION	0-6% NaOH*** 0-12% H_2SO_4***	25 50	3% 6%	— —	— —	073 074	16-82 C 10-82 C	350	411741

*For Automatic Temperature Compensator. Specify as Suffix B when ordering 4973-Series Cells. . .Suffix D when ordering 4800-Series. . .Suffix C when ordering 4905 or 4909-Series. Reference temperature is 25 C

**Resistor part number is for fixed compensator at reference temperature (25 C). For a fixed compensator at other temperatures, specify a PR-type resistor and state temperature.

***A digital meter range of 0-100 is selected to correspond to full-scale non-linear concentration range; a reading of "50" would be interpreted (from a conversion table) as approximately 2.5% on the 0-6% NaOH range, or 5.3% on the 0-12% H_2SO_4 range.

†For best overall accuracy in these ranges, the 7082 Analyzer is recommended. See Data Sheet C2.2211-DS.

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Electrolytic Conductivity

D2.2141-DS

7079-17 Electrolytic Conductivity Transmitter

- **True two-wire transmitter system, to reduce wiring and installation costs; four wire operation available**
- **Isolated 4-20 mA output, proportional to selected conductivity range**
- **Digital readout (LCD), highly visible even in direct sunlight**
- **Switch-selectable ranges, from 0-0.5 to 0-500,000 micromhos/cm (microsiemens/cm), or equivalent microsiemens/m or millisiemens/m; 0-100 ohms-cm to 0-20 megohms-cm; or percent concentration**
- **Built-in check switch for calibration**
- **Automatic or fixed temperature compensation**
- **FM approved Intrinsically Safe for Class I, Division 1, Group A, B, C and D requirements with appropriate L&N barriers**
- **FM approved Explosion Proof for Class I, Division 1, Groups C & D**
- **Plug-in printed-circuit boards for easy servicing**
- **Noryl corrosion-resistant plastic case, NEMA 4X design, suitable for outdoor mounting, with internal conductive coating for effective EMI shielding; or**
- **Cast-aluminum case, NEMA 4 waterproof design for outdoor and explosion-proof installation**
- **Optional external alarm/control modules to provide on/off control**

100.0
micromhos/cm
(microsiemens/cm)
SPECIFIC
CONDUCTANCE

7079-17 Transmitter in Noryl Plastic Case

The L&N 7079-17 Electrolytic Conductivity Transmitter is designed to meet the need—especially in the chemical process industry, and power generation—for an inexpensive two-wire transmitter which produces a current output signal proportional to the selected range (conductance or resistance), with the option of intrinsically safe or explosion-proof operation.

The Transmitter provides a 4-20 mA output signal compatible with MAX™ 1 Distributed Control, Centry® and other process-control systems. Range is displayed on the 3½-digit, seven segment liquid-crystal display. One model provides all ranges; switch-selection of basic ranges, plus switch-selection of multipliers—from X0.01 to X100—and the choice of appropriate cell constants assure maximum versatility of application.

For conductance measurements, ranges are expressed in micromhos/cm, microsiemens/cm. (Microsiemens/cm can be converted to microsiemens/m by multiplying by 100; to millisiemens/m, by multiplying by 0.1; to siemens/m, multiplying by 10^{-4}). For resistance measurements, ranges are expressed in ohms-cm or megohms-cm. For percent concentration measurements, a 0-100 digital range corresponds to the non-linear percentage range (e.g., 0-6% NaOH); a conversion table provides the equivalent percentage value for a digital readout.

Either the metal NEMA 4 or plastic NEMA 4X housing can be used for intrinsically safe loops (24 V two-wire operation) with separately ordered L&N intrinsic safety barriers. The cast aluminum case is explosion proof for Class I, Division 1, Group C and D locations when installed with potted external conduit connections.

The Transmitter receives its 24 V dc supply from an external source. As an alternative, it can be provided with an integral power supply within the case, operating on 120 V, 50-60 Hz (four-wire system).

To provide simple but effective on-off control, a 7080 Alarm/Control Module, with up to 4 plug-in high and/or low alarm/control relays, may be connected to the output circuit of the Transmitter.

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Instrument & System Solutions!

SPECIFICATIONS

Ranges Selectable. Conductance: 0-1, 0-10, 0-100, etc. to 0-100,000, or 0-2, 0-20, 0-200, etc. to 0-200,000, or 0-0.5, 0-5, 0-50, etc. to 500,000 micromhos/cm (microsiemens/cm), or equivalents in microsiemens/m or millisiemens/m. Resistance: 0-100, 0-1K, etc. to 0-10M, or 0-200, 0-2K, etc. to 0-20M ohms-cm. Concentration: 0-6% NaOH and 0-12% H_2SO_4, by conversion table.

Display Conductance: 0-500, 0-1000 or 0-2000, switch-selected, with switch-selected multipliers, X1, X10 or X100. Resistance: 0-1000 or 0-2000, switch-selected, with switch-selected multipliers, X1, X0.1 or X0.01. Concentration: 0-100.0, corresponding to non-linear percentage span; conversion table provided.

LCD Readout Integrally mounted in case. Highly visible liquid-crystal display, 3½ digit (1999 maximum), with ½-inch numerals. Resolution (1 count) depends on range, multiplier and cell constant selected.

Output 4-20 mA dc into 500-ohm (maximum) load, operating on 24 V dc two-wire supply. Input/output isolation, 30 V ac or 60 V dc max.

Function Switch Measure/Check switch in terminal compartment provides (1) cell measurement or (2) measurement of internal precision resistor (±0.25% accuracy) for a calibration check.

Measuring Frequency 80 Hz or 640 Hz, switch-selected. The higher frequency is used for low resistance (high conductance) ranges to reduce the polarization of the electrodes.

Performance Under reference operating conditions.

Display Accuracy: ±0.5% of full scale ±1 count.

Current-Output Accuracy: ±0.5% of full scale.

Range Multiplier: ±0.3% of selected range.

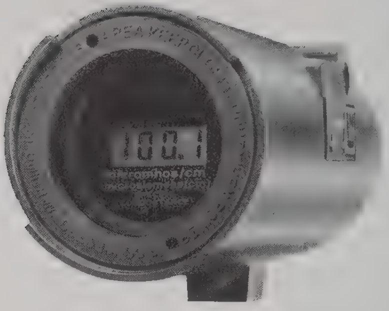
Reproducibility: ±0.2% of full scale, over 1 month.

Linearity: ±0.4% of full scale.

Response Time: Display updated once each second. Current output, 3 seconds for 90% of a step-change.

Reference Operating Conditions: Ambient temperature, 25 C (77 F); Relative Humidity, less than 50%; Line Voltage, 24 V d-c; no vibration, no EMI.

Ambient Temperature Limits 0 to 70 C (32 to 158 F) for rated accuracy; −40 to 80 C (−40 to 176 F) for storage.



7079-17 Transmitter in Metal Case

Relative Humidity Limits 95% max., non-condensing, at 40 C (104 F), except for highest conductance and resistance ranges (90%, max.).

Operating Influences (under reference operating conditions)

Temperature: On zero, ±0.02% of span/°C, max. On span, ±0.02% of span/°C, max.

Voltage: ±0.01% of span per 1% change in 24 V dc supply.

Relative Humidity: ±2% of span over 0-95% R.H. (or 90% R.H., for highest ranges).

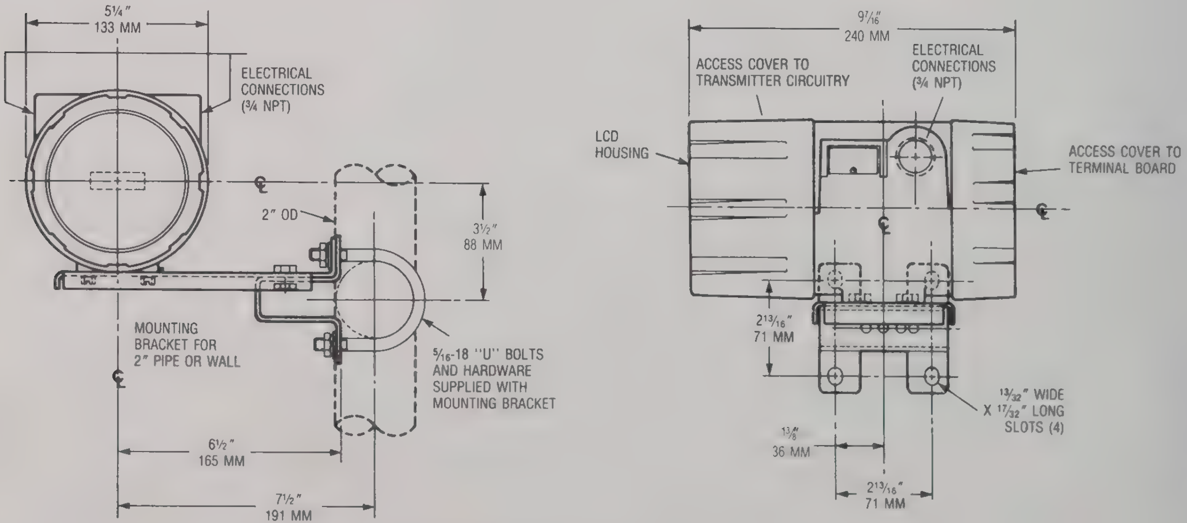
Optional Alarming A separately ordered 7080 Alarm/Control Module, housing one or two plug-in high and/or low alarm/control relays, can be connected to the Transmitter output to provide on-off control or alarming. (Since the Module presents a full 500-ohm load to the Transmitter, any additional load would require a supply greater than 24 V dc.)

Power Requirements 24 V dc supply, two-wire, for 500-ohm (maximum) load.

Optional: Integrally mounted power supply operating on 120 V (108-132 V), 50-60 Hz (47-63 Hz). Maximum load, 500 ohms. Power consumption, 1.6 VA. Over-voltage protection is provided by a 130 V metal-oxide varistor.

Case (1) Noryl plastic corrosion-resistant case, NEMA 4X, with internal conductive coating to provide effective EMI shielding; suitable for outdoor mounting.

(2) Cast-aluminum case, NEMA 4 waterproof design, with urethane polyester finish. Explosion-proof for Class I,


5¼″
133 MM
ELECTRICAL CONNECTIONS (¾ NPT)
℄
2″ OD
3½″
88 MM
MOUNTING BRACKET FOR 2″ PIPE OR WALL
℄
5⁄16-18 "U" BOLTS AND HARDWARE SUPPLIED WITH MOUNTING BRACKET
6½″
165 MM
7½″
191 MM
9 7⁄16″
240 MM
ACCESS COVER TO TRANSMITTER CIRCUITRY
ELECTRICAL CONNECTIONS (¾ NPT)
LCD HOUSING
ACCESS COVER TO TERMINAL BOARD
℄
℄
2 13⁄16″
71 MM
13⁄32″ WIDE X 17⁄32″ LONG SLOTS (4)
1 3⁄8″
36 MM
2 13⁄16″
71 MM

TRANSMITTER DIMENSIONS—PLASTIC CASE

Division 1, Group C and D locations with separately ordered 025858 Potting Kits, for potting conduit connections. (FM approved).

Intrinsic Safety Transmitters can be used for intrinsically safe loops (24 V two-wire operation only) with separately ordered intrinsic safety barriers in Class I, Division 1, Group A, B, C and D locations (FM approved).

Terminations Plastic Case-two ¾″ NPT conduit connections for power supply and cell cable; Metal Case: three ½″ NPT conduit connections for power supply and cell cable.

Mounting Plastic Case-metal bracket for wall or pipe mounting is supplied loose; Metal Case: metal bracket is mounted on case.

Dimensions Plastic case: 5¼″ OD × 9½″ (133 × 241 mm). Metal case: With 24 V dc supply, 4¾″ OD × 9″ (120 × 228 mm); with integral 120 V ac supply, 4¾″ OD × 10½″ (120 × 267 mm).

Weight Noryl plastic case; approximately 4½ lb (2 kg). Cast-aluminum case: approximately 16 lb (7.3 kg).

HOW TO ORDER

Specify appropriate suffixes to complete the catalog number.

A B C D E
7079-17-☐☐-300-☐☐☐-☐☐☐

Suffix A. Type of Measurement

Conductance/Resistance/Concentration	17

Suffix B. Housing

Description	Suffix
NEMA 4 heavy-duty waterproof cast-aluminum case*†	01
NEMA 4X Noryl plastic case*	03

Suffix C. Range

Internally Switch-selectable Ranges (See "Preferred Range and Cell Data" table, back page)	300

Suffix D. Power Supply

Description	Suffix
24 V D-C (Two-Wire System)	024
120 V, 50-60 Hz (Four-Wire System)	120

Suffix E. Tagging

Description	Suffix
None	000
1 Linen Tag, 23 Characters Max, on Each of Six Lines (Specify Legend)	206
1 Aluminum Tag, 15 Characters Max. on One Line (Specify Legend)	207
1 Stainless Steel Tag, 25 Characters Max. on Each of Three Lines (Specify Legend)	208
Same as "208", but permanently mounted on Transmitter	209

ACCESSORIES

FOR INTRINSICALLY SAFE OPERATION

316569 Positive Intrinsic Safety Barrier For negative-ground systems; two required

316747 Negative Intrinsic Safety Barrier For positive-ground systems (e.g., Centry process control); 2 required

FOR EXPLOSION-PROOFING (METAL CASE ONLY)

025858 Potting "Y" Kit Includes ½″ NPT and ¾″ NPT fitting, fiber filling material and potting compound (2 required)

FOR POWER-SUPPLY CONVERSION

Metal Case (One Each Required):

051924 Internal Power Supply Kit Converts 24 V dc two-wire Transmitter to 120 V ac four-wire Transmitter

022324 End-Cover Replaces existing cover

Plastic Case:

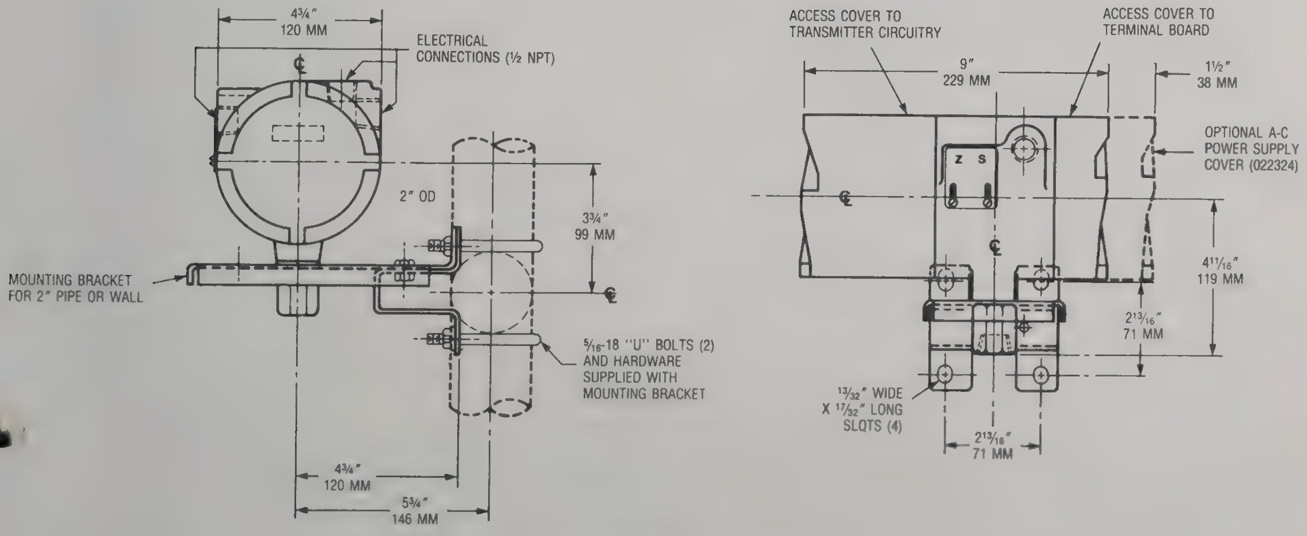
051925 Internal Power Supply Kit (New End-Cover not required)

FOR ALARM/CONTROL FUNCTIONS

7080 Alarm Module (See Data Sheet C12.1390-DS)

** FM approved intrinsically safe for Class I, Division 1, Groups A, B, C and D when used with L&N Intrinsic Safety Barriers (for 24 V dc operation only).*

†To make explosion-proof for Class I, Division 1, Groups C and D (FM approved), order (2) 025858 Potting Kits for external circuit connections. This will not assure an explosion-proof system, since explosion-proof cell housings are not available; for maximum safety, intrinsically safe systems with barriers are recommended—even where the Transmitter has been explosion-proofed.


4¾″
120 MM
ELECTRICAL
CONNECTIONS (½ NPT)
℄
2″ OD
3¾″
99 MM
MOUNTING BRACKET
FOR 2″ PIPE OR WALL
5/16-18 "U" BOLTS (2)
AND HARDWARE
SUPPLIED WITH
MOUNTING BRACKET
4¾″
120 MM
5¾″
146 MM
ACCESS COVER TO
TRANSMITTER CIRCUITRY
ACCESS COVER TO
TERMINAL BOARD
9″
229 MM
1½″
38 MM
Z S
OPTIONAL A-C
POWER SUPPLY
COVER (022324)
4 11/16″
119 MM
2 13/16″
71 MM
13/32″ WIDE
X 17/32″ LONG
SLOTS (4)
2 13/16″
71 MM

TRANSMITTER DIMENSIONS—METAL CASE

Preferred Range and Cell Data (some ranges can be obtained using other cell constants—see directions)

Transmitter Range		Cell Constant	Automatic Temperature Compensator					Fixed Temperature Compensator	
			Reference Conductivity at 25 C	4973 Cells		4800, 4905, 4909 Cells			
				Range Suffix*	Temperature Range	Range Suffix*	Temperature Range	Ohms at 25 C	Part Number**
CONDUCTIVITY, μMHOS/CM (or Equivalent Units)	0-1†	0.01	0.1 0.5	301 303	0-100 C	168 013	0-100 C 0-50 C	350 350	411741 411741
	0-10	0 01	0.5 5	303 305	0-100 C	013 009	0-50 C 0-100 C	350	411741
	0-100 0-1000 0-10,000 0-100,000	0.1 1 10 10	50 500 5000 50,000	305	0-100 C	009	0-100 C	350	411741
	0-2†	0.01	0.1 0.5	301 303	0-100 C	168 013	0-100 C 0-50 C	350 350	411741 411741
	0-20	0.01	0.5 10	303 305	0-100 C	013 009	0-50 C 0-100 C	350	411741
	0-200 0-2000 0-20,000	0.1 1 10	100 1000 10,000	305	0-100 C	009	0-100 C	350	411741
	0-200,000	20	100,000	—	—	009	0-100 C	350	411741
	0-0.5†	0.01	0.1 0.5	301 303	0-100 C	168 013	0-100 C 0-50 C	350 350	411741 411741
	0-5	0.01	0.5 2.5	303 305	0-100 C	013 009	0-50 C 0-100 C	350	411741
	0-50 0-500 0-5000 0-50,000	0.1 1 10 10	25 250 2500 25,000	305	0-100 C	009	0-100 C	350	411741
	0-500,000	50	250,000	—	—	009	0-100 C	350	411741
RESISTIVITY, OHMS-CM	0-20M†	0.01	16.6M	—		—	—	8000	411456
			10M 2M 0 5M	302 304 306	0-100 C	070 014 071	0-60 C	8000	411456
	0-10M†	0.01	10M 2M 0.5M	302 304 306	0-100 C	070 014 071	0-60 C	8000	411456
	0-2M	0 01	2M 0 5M	304 306		014 071			
	0-1M	0.01	0.5M	306		071			
	0-200K	0.01	100K	306		071			
	0-100K	1	50K	306		071			
	0-20K 0-10K	1 1	10K 5K	306		072			
	0-2K 0-1K	1	1K 500	306		072			
	0-200 0-100	10	100 50	306		072			
CONCENTRATION	0-6% NaOH*** 0-12% H_2SO_4***	25 50	3% 6%	— —	— —	073 074	16-82 C 10-82 C	350	411741

*For Automatic Temperature Compensator. Specify as Suffix B when ordering 4973-Series Cells   Suffix D when ordering 4800-Series   Suffix C when ordering 4905 or 4909-Series
Reference temperature is 25 C

**Resistor part number is for fixed compensator at reference temperature (25 C). For a fixed compensator at other temperatures, specify a PR-type resistor and state temperature

***A digital meter range of 0-100 is selected to correspond to full-scale non-linear concentration range; a reading of "50" would be interpreted (from a conversion table) as approximately 2.5% on the 0-6% NaOH range, or 5.3% on the 0-12% H_2SO_4 range.

†For best overall accuracy in these ranges, the 7082 Analyzer is recommended.
See Data Sheet C2.2211-DS.

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pH and Redox

D2.1141-DS

7079 pH or ORP Transmitter

- **True 2-wire (or 4-wire), transmitter system, to reduce wiring and installation costs**
- **Isolated 4-20 mA output, proportional to pH or ORP—oxidation reduction potential**
- **Optional, highly visible Digital Readout (LCD) even in direct sunlight**
- **Switch-selectable ranges: any 2, 4, 6, 8, 10, 12 or 14 pH span over the range of 0-14 pH; ORP over any 400, 600, 800, 1000, 1200 or 1400 mV span**
- **External zero and slope adjustment**
- **FM Approved Intrinsically Safe for Class I, Division 1, Groups A, B, C and D locations—see Specifications**
- **FM Approved Explosion Proof Class I, Division 1, Groups C and D locations—see Specifications**
- **Plug-in printed circuit board for easy servicing**
- **Transient and surge-current protection (lightning protection) standard**
- **Noryl corrosion-resistant plastic case, NEMA 4X design, suitable for outdoor mounting; or NEMA 4 waterproof/explosion-proof cast-aluminum case with corrosion-resistant urethane-polyester finish**
- **Optional external alarm/control module to provide on-off control**

*NEMA 4X
Plastic Case*

*NEMA 4
Metal Case*

The 7079 pH/ORP (Redox) Transmitter is designed to meet the need—especially in the chemical process industry—for an inexpensive two-wire transmitter which produces a current-output signal proportional to a pH or ORP input, with explosion-proof features and intrinsically safe operation.

Offering high performance, and reduced installation cost through its two-wire design, the versatile 7079 Transmitter is compatible with most pH and ORP electrode assemblies currently available, and may be retrofitted to existing two-wire systems. It can be supplied with a low-impedance preamplifier mounted in its case—for operation from direct electrode input signals—or without the preamplifier, for use with electrode assemblies having an integral two-wire type preamplifier.

The Transmitter provides a 4-20 mA output signal, compatible with most process control systems. For pH measurements, range can be 0-14 pH, or any switch-selectable 2, 4, 6, 8, 10 or 12 pH span within the range of 0-14 pH; an external adjustment permits suppressing zero as required (e.g., a 4 pH span could be selected for working range of 6-10 pH). For ORP measurements, calibration permits a choice of any 400, 600, 800, 1000, 1200 or 1400 mV span, to a maximum of 1400 mV; the external adjustment permits zero elevation (e.g., −500 to +500 or 400 to 1000 mV) as desired, which can easily be read on the digital display.

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The Transmitter can be housed in a corrosion-resistant NEMA 4X plastic case (with internal conductive coating for effective EMI/RFI Shielding) or in a NEMA 4 heavy-duty cast-aluminum waterproof case with a urethane-polyester finish. See "Case Classifications" listed in Specifications.

The Transmitter receives its 24 V dc supply from the measuring or controlling instrument (such as a Centry controller), or a separately-ordered 099022 Power Supply. The Transmitter can also be provided with an integral power supply within the case, operating on 120 V, 50/60 Hz (four-wire system).

To provide simple but effective on-off control, a 7080 Alarm/Control Module, with as many as four plug-in high and/or low alarm/control relays, may be connected into the output circuit of the Transmitter.

SPECIFICATIONS

Range With the digital display option, the transmitter will monitor and display the realtime pH value over the full 0-14 pH range. ORP values are displayed over the full 0-1400 mV range when set up as a Redox transmitter.

Whether blind or with optional LCD, the 4-20 mA isolated current output is fully selectable to represent any 2, 4, 6, 8, 10, 12 or 14 pH span, over the range of 0-14 pH; or any 400, 600, 800, 1000, 1200 or 1400 mV span, to a maximum of 1400 mV.

Field span selection for pH is accomplished by internally set switches mounted on the main circuit board.

Note: The LCD readout is not compatible with an antimony electrode due to the large zero offset of the electrode.

Range Adjustment External zero and slope adjustments are provided on the case. For pH measurements, zero can be suppressed as required; for ORP measurements, zero can be evaluated or suppressed as required. The slope adjustment permits matching the Transmitter precisely to the electrode output.

Preamplifier For input signals directly from electrodes, the Transmitter is supplied with a preamplifier (mounted within the case) having 10^{12} ohms input impedance. If an internal preamp is not selected, input signals come from a remote preamp assembly.

Output 4-20 mA dc into 0 to 500 ohms, operating on 24 V dc two-wire supply. See maximum load resistance spec under "Power Requirements."

Optional LCD Readout Integrally mounted in case. Highly visible liquid-crystal display, 3½-digit, with ½" numerals. Resolution 0.01 pH or 1 mV.

Optional Alarming A separately-ordered 7080 Alarm/Control Module, housing from one to four plug-in high and/or low alarm/control relays, can be connected to the Transmitter output to provide on-off control or alarming. (Since the Module presents a full 500-ohm load to the Transmitter, any additional load would require a supply greater than 24 V dc.) For details, see Data Sheet C12.1390-DS.

Performance Under reference operating conditions.

Accuracy: Output, ±0.02 pH or ±1.2 mV.

Drift: For pH, less than 0.01 pH/week; for ORP, less than 1.0 mV/week.

Repeatability: 0.01 pH or 1 mV.

Zero-based Linearity: 0.1% of span.

Reference Operating Conditions: Ambient temperature, 25 C ±1 C (77 F ±1.8F); Relative Humidity, 10 to 40% R.H.; Line Voltage, 24 V dc or 120 V ac.

Operating Influences Under normal operating conditions.

Temperature Influence: 0.002 pH/C (0.0011 pH/F) or 0.2 mV/C (0.11 mV/F).

Humidity Influence: Negligible.

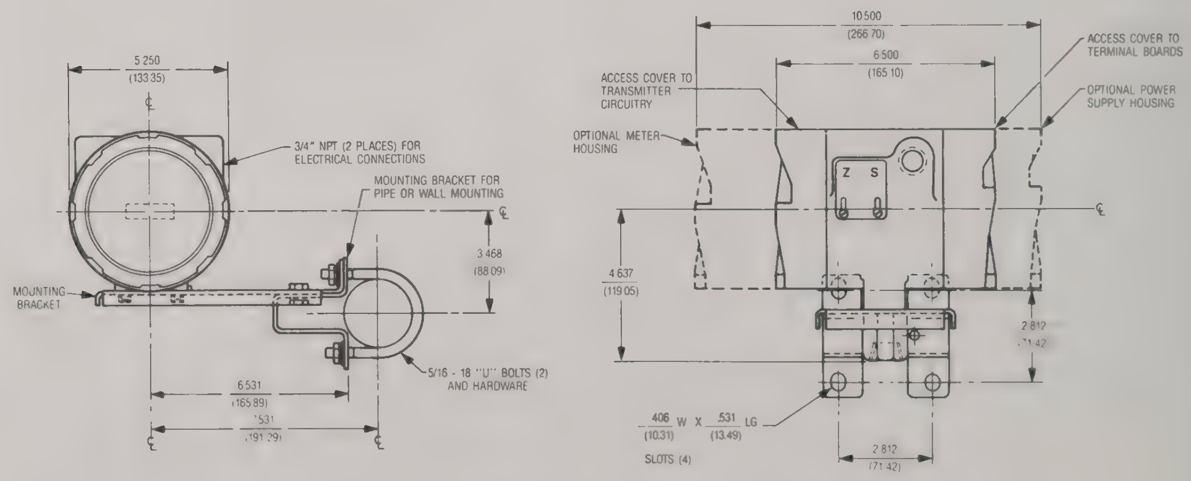
Normal Operating Conditions: Ambient temperature, −10 to +60 C (14 to 140 F); Relative humidity, 10 to 95% R.H.; Line Voltage, 19-34 V dc or 100-132 V, 47-63 Hz.

Power Requirements

Standard: 24 V dc supply, 2-wire (500 ohm max. load). Optional: Integrally mounted power supply operating on 120 V ac (108-132 V), 50-60 Hz. Maximum load is 500 ohms. Power consumption is 1.6 VA. Over-voltage protection is provided by a 130 V metal-oxide varistor.

Maximum Load Resistance (The 7079 drops 14 V regardless of load or power supply)

Power Supply	Max. Load	Power Supply	Max. Load
19 V dc	250 ohms	34 V dc	1000 ohms
24 V dc	500 ohms	120 V ac	500 ohms
29 V dc	750 ohms		


5 250
(133 35)
3/4" NPT (2 PLACES) FOR ELECTRICAL CONNECTIONS
MOUNTING BRACKET FOR PIPE OR WALL MOUNTING
3 468
(88 09)
MOUNTING BRACKET
5/16 - 18 "U" BOLTS (2) AND HARDWARE
6 531
(165 89)
7 531
(191 29)
10 500
(266 70)
6 500
(165 10)
ACCESS COVER TO TERMINAL BOARDS
ACCESS COVER TO TRANSMITTER CIRCUITRY
OPTIONAL POWER SUPPLY HOUSING
OPTIONAL METER HOUSING
Z
S
4 637
(119 05)
2 812
(71 42)
.406 W X .531 LG
(10.31) (13.49)
SLOTS (4)
2 812
(71 42)

TRANSMITTER DIMENSIONS CAST ALUMINUM CASE

Z
S
L&N
LEEDS & NORTHRUP

7079 Transmitter without LCD Readout

Case Classifications:

Metal, Explosion-Proof—FM approved explosion-proof for Class I, Division I, Groups C and D (120 V or 24 V). Must use potting "Y's". See Accessories.

Plastic or Metal, Intrinsically Safe— FM approved Class 1, Division 1, Groups A, B, C and D 24 V version ONLY. Must use approved barriers and be wired in accordance with L&N drawing C-ID-081609-5 for 316569 barriers or C-ID-081609-6 for 316747 barriers.

Case Terminations:

Plastic—Two ¾" NPT conduit connections and one ¾" unthreaded hole in plastic case bottom to allow for electrode cable entry into case. For waterproof installation order one 008555 ¾" NPT conduit hub.

Metal—Choice of three ½" NPT conduit connections for power supply and output leads, one ¾" NPT conduit connection at metal case bottom for electrode cable entry.

Case Mounting:

Plastic—Rugged metal bracket (P/N 055907) is supplied loose.

Metal—Rugged metal bracket is supplied mounted as part of 7079 Case.

Case Dimensions (Diameter x Length):

Plastic—No LCD, 5¼" x 7¾" (133 x 197 mm), 24 V or 120 V.
—With LCD, 5¼" x 9½" (133 x 241 mm), 24 V or 120 V.
Metal —No LCD, 4¾" x 6½" (120 x 165 mm), 24 V.
—With LCD, 4¾" x 9" (120 x 228 mm), 24 V.
—No LCD, 4¾" x 8" (120 x 203 mm), 120 V.
—With LCD, 4¾" x 10½" (120 x 267 mm), 120 V.

Case Weight:

Plastic—4½ lbs (2 kg): **Metal**—16 lb (7.3 kg).

HOW TO ORDER

Specify appropriate suffixes to complete the catalog number.

A B C D E
7079-☐☐-☐☐-☐☐☐-☐☐☐-☐☐☐

Suffix A. Type of Measurement

Type	Description	Suffix
pH	For use with external 022586 preamplifier (or 026395 preamp module) located remotely from a 7079-11, or for use with 075704 preamp module using Meredian II electrodes with a quick-disconnect plug. Recommended when electrodes are more than 10 feet from the transmitter.	11
	Includes internal preamplifier 075725 located within transmitter. For use with Meredian II combination pH electrodes without a quick-disconnect plug. Electrode assembly must be within 10 feet of the transmitter.	44
	Includes internal preamplifier 022123 located within transmitter. For use with Meredian combination or conventional individual pH electrodes.	33
ORP (Redox)	Includes internal preamplifier 022123 located within transmitter (recommended when electrodes are less than 1000 feet from the transmitter). For use with all L&N industrial ORP electrodes.	22

Suffix B. Electrical Classification

Description	Suffix
NEMA 4 heavy-duty waterproof metal case. See notes 1 and 2.	01
NEMA 4X waterproof corrosion-resistant Noryl plastic case. See notes 1 and 3.	03

Note 1: Approved by FM, intrinsically safe for Class I, Division 1, Groups A, B, C and D when connected in accordance with L&N Drawing C-ID-081609-5 or C-ID-081609-6 (Must be 24 V, 2-wire only.)

Note 2: Approved by FM, for explosion-proof Class I, Division 1, Groups C and D locations. To make explosion-proof, order a 025858 Potting Kit for external circuit connections. This will not assure an explosion-proof loop, since explosion-proof electrode housings are not available; for maximum safety, intrinsically safe systems with barriers are recommended — even where the Transmitter housing has been explosion-proofed.

Note 3: For waterproofing plastic case, order a 008555 conduit hub

Suffix C. Ranges

	Range	Suffix
Without LCD Readout	0-14 pH 0-1000 mV	000 001
With LCD Readout	0-14 pH 0-1000 mV	247 200

Suffix D. Power Supply

Description	Suffix
24-V D-C, Two-Wire System (must for I.S. systems)	024
120-V, 50-60 Hz, Four-Wire System	120

Suffix E. Tagging

Description	Suffix
None	000
1 Linen Tag, 23 Characters Max. on Each of Six Lines (Specify Legend)	206
1 Aluminum Tag, 15 Characters Max on One Line (Specify Legend)	207
1 Stainless Steel Tag, 25 Characters Max. on Each of Three Lines (Specify Legend)	208
Same as "208", but permanently mounted on Transmitter	209

ACCESSORIES

For Intrinsically Safe Operation

316569	Positive Intrinsic Safety Barrier (for negative-ground systems); two required
316747	Negative Intrinsic Safety Barrier (for positive-ground systems; e.g., Centry process control); two required

For Explosion-Proofing (metal case only)

025858	Potting "Y" Kit; includes one ½" NPT and one ¾" NPT Fitting, fiber filling material and potting compound (for 120 V loop, order an extra 025857 potting "Y")

For External Power Supply

099022	24-V Power Supply, two-wire, in NEMA 4 box. Maximum current, 100 mA (sufficient for 5 Transmitters)
022586	Preamplifier (External to 7079-11, in electrode mounting assembly)
026395	Preamplifier Module (External to 7079-11, in separate case)
075704	Meredian II Preamplifier Module (External to 7079-11, in separate round case)

For Power-Supply Conversion

Metal Case (one each required):

025856	Internal Power Supply Kit; converts 24 V dc two-wire Transmitter to 120 V ac four-wire Transmitter
022324	End Cover (replaces existing cover)

Plastic Case:

051925	Internal Power Supply Kit (new End Cover not required)

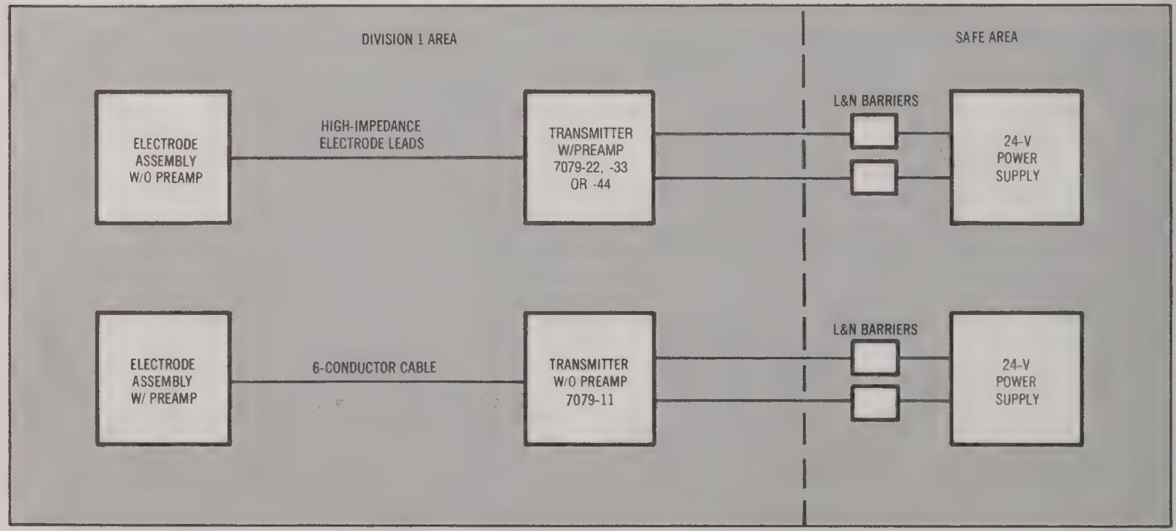
For Alarm/Control Functions

7080	Alarm Module (For details, see Data Sheet C12.1390-DS)

REPLACEMENT PARTS

021594	Main Amplifier Printed-Circuit Board
022123	Preamplifier (Internal in 7079-22, -33)
075725	Preamplifier (Internal in 7079-44)

INTRINSICALLY SAFE TRANSMITTER INTERCONNECTIONS FM APPROVED


DIVISION 1 AREA
SAFE AREA
ELECTRODE ASSEMBLY W/O PREAMP
HIGH-IMPEDANCE ELECTRODE LEADS
TRANSMITTER W/PREAMP 7079-22, -33 OR -44
L&N BARRIERS
24-V POWER SUPPLY
ELECTRODE ASSEMBLY W/ PREAMP
6-CONDUCTOR CABLE
TRANSMITTER W/O PREAMP 7079-11
L&N BARRIERS
24-V POWER SUPPLY

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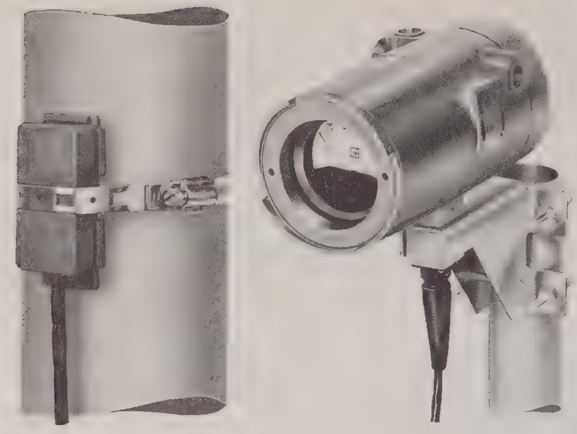
Flow

C4.3111-DS

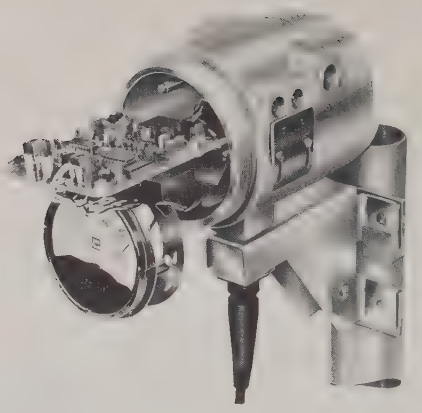
L&N 475-Series Ultrasonic Doppler Flowmeter

- Non-intrusive, obstructionless flow measurements — simple, accurate, reliable
- Cost is independent of pipe size
- 4-20 mA output, proportional to flow
- Output meter, calibrated 0-100%, integral with case
- Three ranges—0-5, 0-10 and 0-20 fps—allowing full-scale measurement from 3.5 to 40 feet per second
- External span and threshold adjustments
- Temperature-compensated transducer to prevent changes in output due to variations in ambient or process temperature
- Heavy-duty case, NEMA 4 waterproof design, with corrosion-resistant polyvinyl-chloride finish
- Plug-in printed-circuit board for easy on-site servicing
- Self-contained frequency source permits on-site calibration
- Crystal-controlled oscillator, stable over full operating temperature range
- Output circuit insensitive to frequency drift — spurious noise — pipe vibration
- Quick-disconnect transducer cable
- 24 V d-c or 120 V a-c operation
- Easy to install — easy to calibrate — highly reliable

LEEDS & NORTHRUP
A UNIT OF GENERAL SIGNAL



Quick-disconnect cable connects Flowmeter to integral transducer/sensor head, which is mounted on the surface of the measured pipe.



With threaded end-covers removed, printed-circuit card and meter can be repositioned for easy calibration or checking.

The 475-Series Ultrasonic Doppler Flowmeter determines the velocity of a liquid in a pipe by sensing the frequency change of an ultrasonic signal, caused by the motion of the liquid.

The Flowmeter is obstructionless, consisting of a transducer/sensor — easily attached to the outside of the pipe — connected by cable to the remotely mounted electronics housing.

Operation

The transducer/sensor utilizes twin crystals in a single housing, one for transmitting the ultrasonic signal, the other for detecting the reflected signal. In operation, an ultrasonic wave is projected through the pipe wall at an angle into the fluid. Part of the ultrasonic energy is reflected by bubbles or particles ("reflectors") and is returned through the pipe wall to the transducer/sensor for detection and processing by the electronic circuitry.

Since the reflectors are traveling at the same velocity as the fluid, the frequency shift of the reflected wave will be proportional to flow rate. The Doppler frequency is a linear function of flow velocity and of the variables associated with the construction of the transducer/sensor and the electronic detector; operation of the Flowmeter is independent of the pipe material, and temperature, composition, density and viscosity of the fluid.

Reflectors

The Flowmeter will measure correctly as long as a quantity of entrained air (bubbles) or solids is present in the liquid. Without them, the transmitted signal is not reflected back to the receiver.

When there are no entrained gases, a minimum concentration of solid particles is required for effective measurement.

Pipes with poor ultrasonic transmission characteristics (concrete, or badly corroded metal) are not suitable for ultrasonic flowmeter application.

Description

The 475 Flowmeter is housed in a NEMA 4 waterproof die-cast aluminum case. A slide-cover protects the external span and threshold adjustments; sliding the cover down exposes them without violating the waterproofing. The threaded rear end-cover can be removed for ready access to the terminal board and connections to external power source (24 V d-c or 120 V a-c) and load (0 to 550 ohms). Three ½″ NPT conduit connections offer alternate outlets for power and load leads.

The threaded front cover with window and the output meter (calibrated 0-100%) can be removed to expose the electronics printed-circuit card, its connector, and the test points for calibration.

The Flowmeter is specified with either a 20- or 40-foot cable, with a plug-in connector to the electronics housing on one end and a transducer/sensor head on the other. The head is a single unit which can be strapped directly to pipes larger than 4″. For smaller pipes—1″ to 4″—one of the three saddles (supplied) must be used. In either case, epoxy or ultrasonic couplant (also supplied) must be used as a coupling medium between the mating surfaces of the pipe, saddle and transducer.

The transducer contains two crystals; one transmits an ultrasonic signal through the pipe wall into the liquid, the second detects a signal reflected by the particles or bubbles in the liquid. The epoxy or couplant used between all mating surfaces helps assure suitable transmission of the ultrasonic signals.

A velocity range—0-5, 0-10 or 0-20 fps—is selected by a jumper on the electronics printed-circuit card. The span-adjustment potentiometer permits continuous adjustment of the meter, and the 4-20 mA output, to permit readings from 3.25 to 40 fps full-scale. Minimum measurable velocity is a function of suspended-solids settling.

The "dry calibration" feature is accessed via a jumper on the printed-circuit card, and permits calibration without the transducer being connected to a pipe.

The proprietary threshold circuit may be adjusted to eliminate upscale readings caused by spurious low-amplitude signals generally found at no-flow conditions.

An additional benefit of the threshold circuit is to serve as a monitor of the reflected-signal amplitude. If the return signal amplitude is too low to give an accurate or reliable indication, the output will be driven to zero.

The circuit performs its function without affecting the sensitivity or gain of the detection circuitry.

SPECIFICATIONS

INPUT

Sensor: Ultrasonic sensor, mounted on pipe and connected to electronics housing through a protected shielded cable.

Range: Jumper-selected ranges, 0-5, 0-10 and 0-20 fps.

Span Adjustment: External span adjustment, on case, of 0-65% to 0-200% of range provides range spans from 0-3.25 to 0-40 fps, for optimum resolution.

Threshold Adjustment: External threshold adjustment on case, permits cutting off spurious low-level signals generated by vibration at no-flow conditions without eliminating any portion of the Doppler signal.

OUTPUT

Standard: 4-20 mA d-c into 0 to 550 ohms.

Output Meter: Standard meter, integrally mounted in the case, has 0-100% calibration. Scale length, 4½″ (114 mm).

PERFORMANCE*

Accuracy: Factory Calibration: ±2% of span for a 30-second average, using water at 25 C in a 1.5″ Schedule 40 pipe.

On-Site Calibration, Wet: ±2% of span, plus the reference uncertainty.

On-site Calibration, Dry: ±5% of span, using the internal reference, for nominal pipe sizes from 1″ to 8″ and particle concentrations to 5%. The meter may be used on pipe sizes greater than 8″, or with concentrations greater than 5%; consult factory for calibration factors.

Repeatability: 0.1% of reading.**

Linearity: 0.1% of span.**

OPERATING INFLUENCES

Temperature Coefficient: For electronics: 0.02% of span per °C (0.01% of span per °F).

Operating Limits: For electronics housing: − 23 to 60 C (−10 to 140 F). For transducer/sensor: −23 to 180 C (−10 to 356 F).

Storage Limits: −23 to 93 C (−10 to 200 F).

Relative Humidity: 90% R.H. at 40 C (104 F) per ANSI 39.4.

Load: Output varies less than 0.1% of span over the range of 0 to 550 ohms.

** From 2 ft/sec to full span.*

*** Under simulated flow conditions.*

POWER REQUIREMENTS

Standard: 24 ±1.5 V d-c supply; 100 mA.

Optional: Integrally mounted power supply operating on 108/132 V, 50/60 Hz; 25 mA.

CONSTRUCTION

Case: Cast-aluminum, NEMA 4 waterproof design, with corrosion-resistant polyvinyl-chloride finish. (Unused conduit connections must be plugged—using 276403 Plug, separately ordered—to complete waterproofing.)

Terminations: Internal terminal board, accessible behind threaded end-cover; choice of three ½″ NPT conduit connections for power-supply and signal-output leads.

Mounting: Bracket included to permit mounting on wall or 2″ OD vertical or horizontal pipe.

Case Dimensions: 4¾″ OD × 9″ long (120 × 228 mm). (Cable to sensor is 20′ or 40′ [6 or 12m], as specified.)

Weight: With 20′ cable: 14 lb (6.4 kg), approx. With 40′ cable: 16 lb (7.5 kg), approx.

ORDERING INSTRUCTIONS

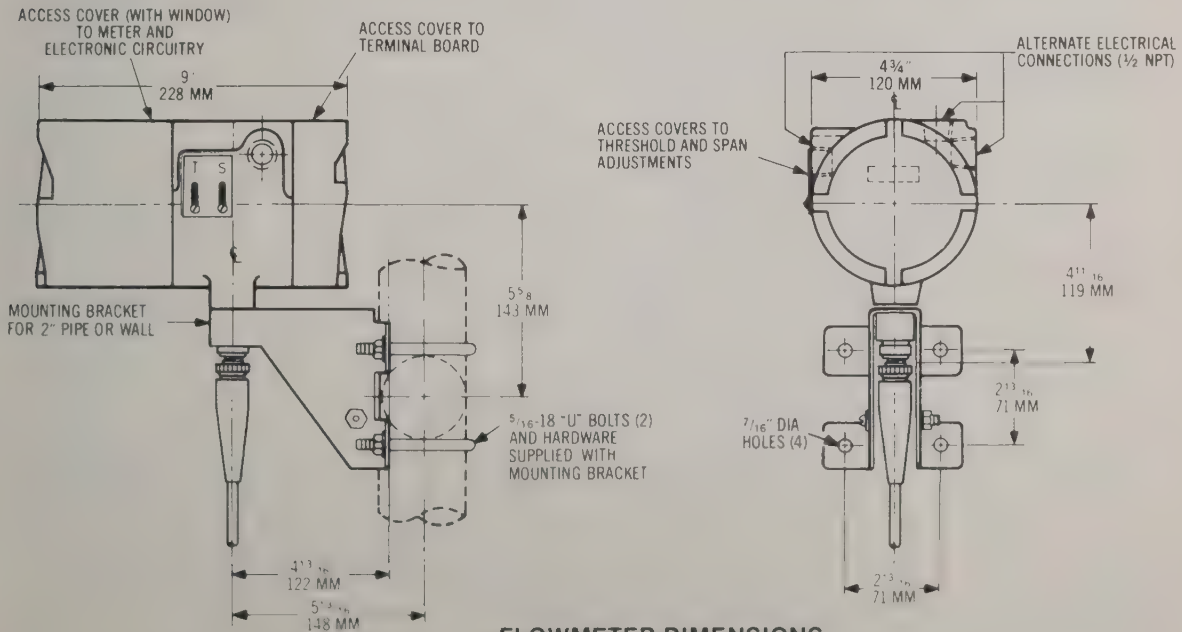
Specify appropriate suffixes to complete the catalog number.

A B
475-☐-☐☐☐

Suffix A. Cable Length	
20-Foot Cable	**1**
40-Foot Cable	**2**
Suffix B. Power Supply	
24-V D-C	**024**
120-V A-C	**120**

Note: A strap used to hold the sensor to a pipe up to 10″ in size is supplied with each Flowmeter. For pipes up to 20″, order one 025889 Kit; up to 30″, two Kits; up to 42″, three Kits; up to 48″, four Kits. Three saddles of different curvature, and a supply of ultrasonic couplant, are also provided with each Flowmeter.

To complete the waterproofing of the Flowmeter case, order two 276403 Plugs to close the unused conduit connections.


ACCESS COVER (WITH WINDOW) TO METER AND ELECTRONIC CIRCUITRY
ACCESS COVER TO TERMINAL BOARD
9″
228 MM
T
S
MOUNTING BRACKET FOR 2″ PIPE OR WALL
5 5/8
143 MM
5/16-18 "U" BOLTS (2) AND HARDWARE SUPPLIED WITH MOUNTING BRACKET
4 13/16
122 MM
5 13/16
148 MM
ALTERNATE ELECTRICAL CONNECTIONS (½ NPT)
4¾″
120 MM
ACCESS COVERS TO THRESHOLD AND SPAN ADJUSTMENTS
4 11/16
119 MM
2 13/16
71 MM
7/16″ DIA HOLES (4)
2 13/16
71 MM

FLOWMETER DIMENSIONS

L&N Field Offices

AL 35216, Birmingham, 600 Vestavia Parkway, Suite 151 (205) 823-2610
36609, Mobile, 1 Office Park, Suite 118 (205) 342-8929
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DE 19703, Wilmington, 1502 Society Drive, Claymont (302) 792-0200
DC 21044, Washington, 5585 Sterrett Pl., Suite 104, Columbia, MD (301) 621-5245
FL 32216, Jacksonville, 2121 Corporate Square Blvd., (904) 725-3563
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IL 60018, Chicago, 10600 W. Higgins Rd., Rosemont (312) 775-4141
60473, South Holland, 515 W. Taft Drive (312) 596-8480
IN 46220, Indianapolis, 6314 Rucker Rd., Suite D (317) 259-7161
IA 52722, Davenport, 2435 Kimberly Rd., Bettendorf (319) 355-6481
KS 66202, Kansas City, 6811 W. 63rd St., Shawnee Mission (913) 432-3727
KY 40207, Louisville, 133 Executive Park (502) 897-0631
LA 70816, Baton Rouge, 2644 Sherwood Forest Blvd. S., Suite 101 (504) 292-6606
71105, Shreveport, 3000 Knight Office Pl., Suite 167 (318) 226-1615
MD 21044, Baltimore, 5585 Sterrett Pl., Suite 104, Columbia (301) 995-0494
MA 02026, Boston, 875 Providence Hwy., Dedham (617) 326-8816
MI 48237, Detroit, 20820 Greenfield Rd., Oak Park (313) 967-1033
49508, Grand Rapids, 2186 44th St., S.E. (616) 455-7070
MN 55343, Minneapolis, 11573 K-Tel Drive, Minnetonka (612) 933-7372
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14619, Rochester, 167 Flanders St. (716) 235-1700
13066, Syracuse, 7000 E. Genesee St., Fayetteville (315) 446-8446
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27103, Winston-Salem, 200 Charlois Blvd. (919) 765-6580
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44720, Canton, 5906 Mayfair Rd., N.W., N. Canton (216) 499-1800
45236, Cincinnati, 7659 Montgomery Rd. (513) 791-2274
44092, Cleveland, 28300 Euclid Ave., Wickliffe (216) 261-9003
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44420, Youngstown, 1601 Motor Inn Dr., Suite 240, Girard (216) 759-7028
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OR 97221, Portland, 6415 Southwest Canyon Court (503) 227-4964
PA 18104, Allentown, 1401 Cedar Crest Blvd., Suite 108 (215) 434-4417
19044, Phila., 281 Gibraltar Rd., Horsham (215) 441-5600
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TX 75081, Dallas, 833 Arapaho E., Suite 207, Richardson (214) 234-3363
77477, Houston, 10521 Corporate Drive, Stafford (713) 491-6000
UT 84107, Salt Lake City, 5278 Pinemont Dr., Suite A-180 (801) 266-6931
VA 23225, Richmond, 300 Turner Rd., Suite A (804) 276-9720
24015, Roanoke, 2728 Colonial Ave., S.W., Suite 2 (703) 345-9532
WA 98005, Seattle, 12505 Bellevue-Redmond Rd., Suite 101, Bellevue (206) 451-9028
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Flow

C4.3112-DS

L&N 775-Series Microprocessor Doppler Flowmeter

- Non-intrusive, obstructionless flow measurement
- Cost independent of pipe size
- All application-oriented options provided as standard features in one microprocessor-based model
- Highly visible customized liquid-crystal display (LCD) of flow, flow units, flow variables, diagnostic routines
- Integral totalizer, with separate continuous LCD display of total volume
- Simple keyboard entry of flow and process parameters ("I.D.", "FULL SCALE", etc.) and pushbutton access to diagnostics
- Adjustable damping
- Adaptive digital smoothing of output signal
- Self-diagnostic program to verify correct Flowmeter operation and assist in trouble-shooting
- Battery backup to retain totalized volume and process parameters upon loss of power
- Opto-isolated 4-20 mA output proportional to full-scale flow for remote readout and/or control
- Selection of high- or low-flow alarm, batch (volume) alarm, or remote totalizer
- Output insensitive to frequency drift—spurious noise—pipe vibration
- Quick-disconnect transducer cable
- 120-V a-c operation
- Compact NEMA 4X weatherproof, corrosion-resistant, RF-shielded case for indoor or outdoor mounting
- Meets Class I, Division 2, Group B, C and D requirements
- Easy to install—easy to calibrate—highly reliable

LEEDS & NORTHRUP INSTRUMENTS
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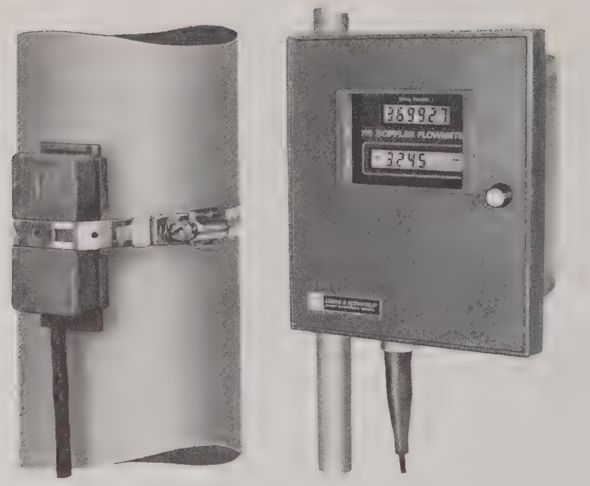


Quick-disconnect cable connects Flowmeter to integral transducer/sensor head, which is mounted on the surface of the measured pipe.

The 775-Series Microprocessor Doppler Flowmeter determines the velocity of a liquid in a pipe by sensing the frequency change of an ultrasonic signal, caused by the motion of bubbles or particles in the liquid.

The Flowmeter is microprocessor-based for ease of calibration and measurement, and is obstructionless, consisting of a transducer/sensor—easily attached to the outside of a pipe—connected by a detachable cable to the remotely mounted electronics housing.

Operation

The transducer/sensor utilizes twin crystals in a single housing, one for transmitting the ultrasonic signal, the other for detecting the reflected signal. In operation, an ultrasonic wave is projected through the pipe wall at an angle into the liquid. Part of the ultrasonic energy is reflected by bubbles or particles ("reflectors") and is returned through the pipe wall to the transducer/sensor for detection and processing by the electronic circuitry.

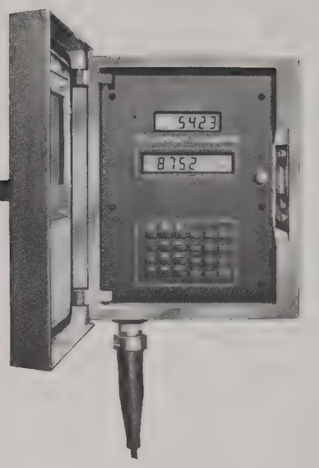
Since the reflectors are traveling at the same velocity as the liquid, the frequency shift of the reflected wave will be proportional to flow rate. The Doppler frequency is a linear function of flow velocity and of the variables associated with the construction of the transducer/sensor and the electronic detector. Operation of the Flowmeter is independent of the temperature, density and viscosity of the liquid, and of the pipe material; however, pipes with poor ultrasonic transmission characteristics (concrete, or badly corroded metal) are not suitable for ultrasonic flowmeter application.

Reflectors

The Flowmeter will measure correctly as long as a quantity of entrained gas (bubbles) or solids is present in the liquid. Without these reflectors, the transmitted signal is not reflected back to the receiver.

Meter

The microprocessor-based electronic circuitry is housed in a Noryl plastic case, with a door which provides access to the keyboard on the front panel. The transducer cable plugs into a connector on the bottom of the case: openings in the bottom of the case facilitate field connections for the 120-V a-c power supply, and for outputs (4-20 mA, and to a remote totalizer or alarm device)



Hinged door on the Flowmeter provides ready access to the keyboard on the front panel, for accessing the microprocessor.

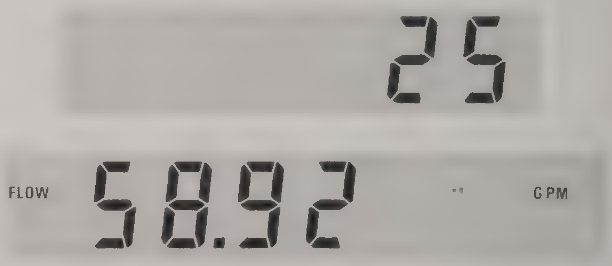
The upper LCD displays the total volume of the liquid being measured; the lower LCD provides a continuous display of the flow rate, but is also used to indicate numerical values for calibration and test.

Total Volume Display (Upper): This six-digit display totalizes the volume flow in gallons or liters; for other units, a scaling factor can be entered. Example: To set the display to read "gallons × 42" (barrels), the "VOL/PULSE" pushbutton is pressed, then the "4" and "2" pushbuttons; the "UNITS" pushbutton is pressed successively until "G" (for gallons) appears in the *lower* display; the "ENTER" pushbutton is pressed, and the Total Volume Display will then advance one count for each 42 gallons (one barrel) measured.

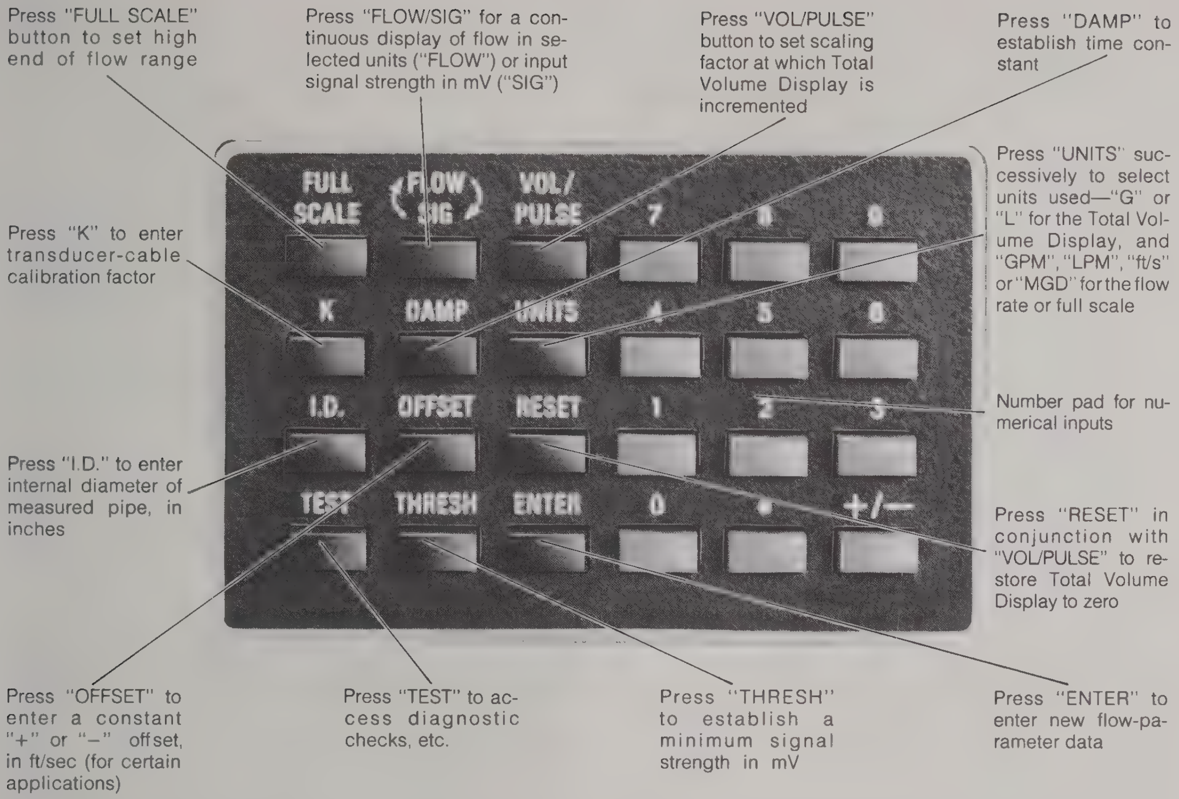
Pressing the "VOL/PULSE" pushbutton at any time will bring up the assigned volume parameters—e.g., "42" and "G"—in the lower display. The Total Volume Display can be reset to zero using the "RESET" button in conjunction with the "VOL/PULSE" button.

Main Display (Lower): The primary function of the lower LCD is to continuously display the flow rate. Pressing the "FLOW/SIG" pushbutton alternately displays the flow rate in selected units, or the input signal strength in millivolts. Flow-rate units—feet per second, gallons per minute, liters per minute, megagallons per day, or percent of full scale—are established by the "UNITS" and "ENTER" pushbuttons.

If the signal strength from the transducer/sensor drops below the threshold value (established with the



LCD displays (shown actual size) indicate Total Volume (upper) and, typically, flow rate in GPM in the Main Display (lower). The Main Display is also used, in conjunction with various pushbuttons, to display appropriate numerical values and legends for calibration and test.


Press "FULL SCALE" button to set high end of flow range
Press "FLOW/SIG" for a continuous display of flow in selected units ("FLOW") or input signal strength in mV ("SIG")
Press "VOL/PULSE" button to set scaling factor at which Total Volume Display is incremented
Press "DAMP" to establish time constant
Press "UNITS" successively to select units used—"G" or "L" for the Total Volume Display, and "GPM", "LPM", "ft/s" or "MGD" for the flow rate or full scale
Press "K" to enter transducer-cable calibration factor
Number pad for numerical inputs
Press "I.D." to enter internal diameter of measured pipe, in inches
Press "RESET" in conjunction with "VOL/PULSE" to restore Total Volume Display to zero
Press "OFFSET" to enter a constant "+" or "−" offset, in ft/sec (for certain applications)
Press "TEST" to access diagnostic checks, etc.
Press "THRESH" to establish a minimum signal strength in mV
Press "ENTER" to enter new flow-parameter data
FULL SCALE
FLOW SIG
VOL/ PULSE
7
8
9
K
DAMP
UNITS
4
5
6
I.D.
OFFSET
RESET
1
2
3
TEST
THRESH
ENTER
0
•
+/−

Simplified pushbutton array on front panel (shown actual size) permits calling up continuous display of measured values or calibration parameters on LCDs . . . accesses microprocessor for calibrating, alarming and test functions

"THRESH" pushbutton), the flow-rate display will flash, "LOW SIG" will appear in the display, the output signal will be held constant at 2 mA and the totalizer will not be incremented. The threshold value may therefore be adjusted to eliminate upscale readings caused by spurious, low-amplitude, vibrational signals commonly found at no-flow conditions.

The lower display is also used in conjunction with various other pushbuttons to establish numerical parameters critical to flow measurement: the transducer-cable calibration factor ("K"), internal pipe diameter ("I.D."), the full-scale flow corresponding to a 20-mA output ("FULL SCALE"), time constant ("DAMP") and flow offset, used for certain applications ("OFFSET").

A "TEST" pushbutton, in conjunction with a series of test-code numbers, provides various functions, including

. . . LCD check (all segments on)
. . . circuit diagnostics
. . . transducer-head temperature measurements
. . . batch, high and low alarm settings
. . . internal clock/calendar setting
. . . power down-time monitoring, and
. . . preset output currents for calibrating auxiliary devices.

Transducer/Sensor

The 775 Flowmeter is specified with either a 20- or 40-foot cable, with a plug-in connector to the electronics housing on one end and a transducer/sensor head on the other. The head is a single unit which can be strapped directly to pipes larger than 4". For smaller pipes—1" to 4"—one of the three saddles (supplied) must be used. In either case, epoxy or ultrasonic couplant (also supplied) must be used as a coupling medium between the mating surfaces of the pipe, saddle and transducer to assure suitable transmission of the ultrasonic signals.

SPECIFICATIONS

GENERAL

Transducer: Ultrasonic transducer, mounted on pipe and connected to electronics housing through a 20- or 40-foot cable by means of a quick-disconnect connector.

Range: Ranges are selected by keyboard entry, with no limit on either high or low range selection. (Performance as specified is for flow velocities between 0.5 and 40 ft/s.)

Memory Backup: Internal lithium primary battery will provide 6 months data retention upon loss of power.

OUTPUT

Current: Opto-isolated, 4-20 mA d-c into 0-600 ohms, with 10% overrange capability; 2 mA output at "LOW SIG" indication.

Main Display (Lower LCD): 6-digit indication of flow to 4 significant digits. Flow units of MGD, LPM, GPM, ft/s or % may be selected.

Total Volume Display (Upper LCD): 6-digit indication of total volume. Keyboard permits totalizing in gallons or liters (or other engineering units).

Relay: SPST, for remote totalizer or alarms. Rating, 10 W (4 W inductive), 0.5 A, 135 V a-c or 200 V d-c, max. (Product of voltage and current cannot exceed 10 W resistive.) Normally open (NO) operation; momentary closure (65 milliseconds) for batch alarm or remote totalizer; continuous closure for activated high or low alarm.

PERFORMANCE*

Accuracy: Factory Calibration: ±2% of span for a 30-second average, using water at 25 C in a 1.5" Schedule 40 pipe.

On-Site Calibration, Wet: ±2% of span, plus the reference uncertainty.

On-Site Calibration, Dry: ±5% of span for nominal pipe sizes from 1" to 8" and particle concentrations to 5%.

Repeatability: 0.1% of reading.**

Linearity: 0.1% of span.**

OPERATING INFLUENCES

Solids Requirement: Solids must be greater than 43 microns (325 mesh). Concentrations to 30% by volume have been tested; consult factory for specifications.

Pipe-Size Limitations: Pipes must be between 1" and 72" in diameter; consult factory for application with larger pipe sizes.

Temperature Coefficient: For electronics: 0.02% of span per °C (0.01% of span per °F).

Operating Limits: For electronics housing: −23 to 60 C (−10 to 140 F). For transducer/sensor: −23 to 180 C (−10 to 356 F).

Storage Limits: −23 to 70 C (−10 to 158 F).

Relative Humidity: 90% R.H. at 40 C (104 F) per ANSI 39.4.

Load: Output varies less than 0.1% of span over the range of 0 to 600 ohms.

POWER REQUIREMENTS

Power Requirements: Operates on 108-132 V, 50/60 Hz (100 mA).

**Provided reflectors remain in homogeneous suspension.*

***Under simulated flow conditions*

CONSTRUCTION

Case and Door: Rugged gray Noryl case, NEMA 4× and 3R; ANSI C39.5 Enc. 4 and 5 (weatherproof, corrosion-resistant, dust-tight, outdoor). RF shielding in interior of case.

Electrical Classification: Suitable for non-hazardous and Class I, Division 2, Group B, C and D locations.

Terminations: Internal terminal board accessible behind front cover permits connections for power-supply and signal-output leads. Quick-disconnect transducer cable connects to adapter at bottom of case.

Case Dimensions: Overall: 9¼" (w) × 10⅞" (h) × $8^{1}/_{16}$"(d) (235 × 276 × 205 mm). Behind front surface of a panel: 7⅛" (w) × 9¾" (h) × 5⅞" (d) (181 × 248 × 149 mm).

Mounting: Hardware furnished to panel-, surface- or pipe-mount the case.

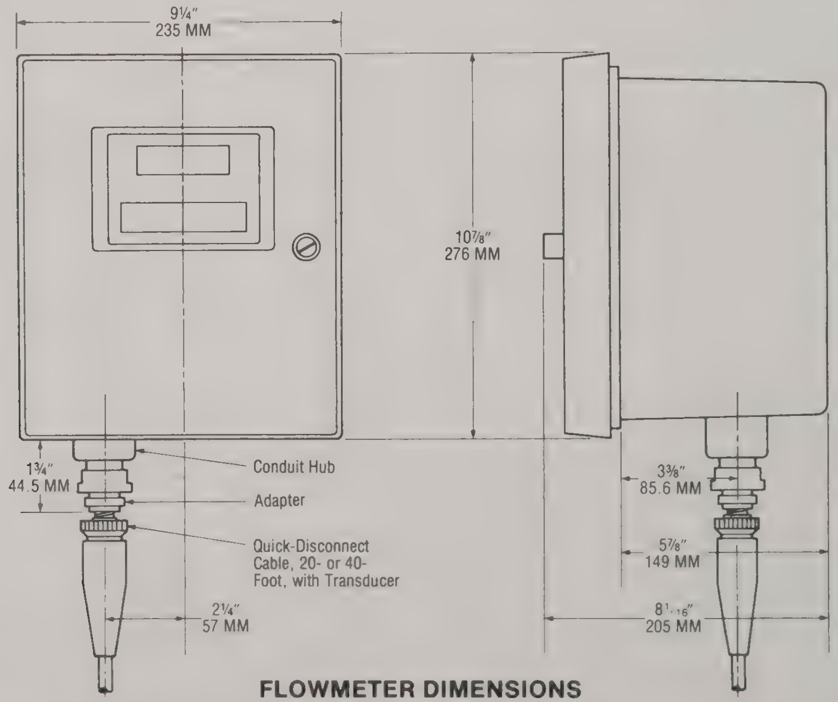
HOW TO ORDER

Specify the appropriate suffix to complete the catalog number.

A
775-☐-120

Suffix A. Cable Length	
20-Foot Cable	**1**
40-Foot Cable	**2**

Note: A strap used to hold the sensor to a pipe up to 10" in size is supplied with each Flowmeter. For pipes up to 20", order one 025889 Kit; up to 30", two Kits; up to 42", three Kits; up to 48", four Kits. Three saddles of different curvature, and a supply of ultrasonic couplant, are also provided with each Flowmeter.



FLOWMETER DIMENSIONS

LEEDS & NORTHRUP
INSTRUMENTS North Wales, Pa. 19454
A UNIT OF GENERAL SIGNAL

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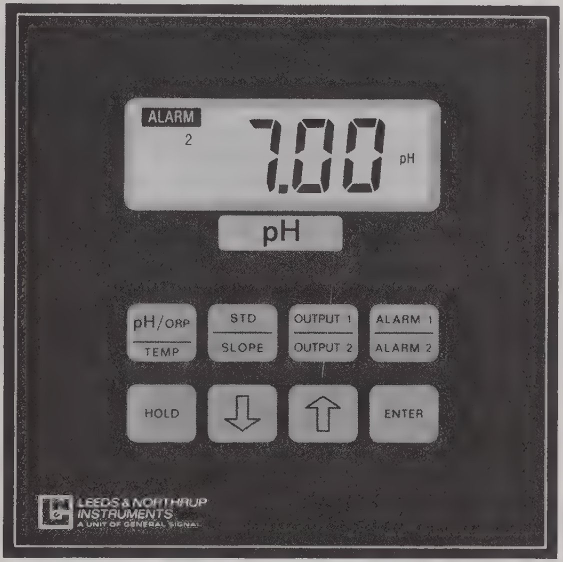
7082 pH/ORP Analyzer

- **Highly visible custom LCD, displays pH/ORP, temperature, setpoints and status messages with 0.01 pH/1 mV resolution**
- **Field selection of pH or ORP—Oxidation Reduction (Redox) Potential measurement**
- **Input from quick disconnect preamplifier or directly from pH electrode**
- **Superior analog and digital design permits up to 3,000 ft. separation of electrode/preamp and analyzer**
- **Efficient one or two point calibration with no interaction using dedicated STD/SLOPE key**
- **Unique solution temperature compensation for repeatable demineralized water and steam condensate measurements**
- **Output can represent any pH/mV range within −2.00 to 14.00 pH or −1999 to 1999 mV**
- **Optional isolated outputs: 0-1 and 0-10V, 4-20 mA**
- **Two SPDT, Form C, 3-amp alarm relays**
- **On-off or proportional-only control**
- **Meets Class I, Division 2, Group A, B, C & D requirements when relays are not used**
- **Extensive on-line diagnostics continuously verify analyzer operation**
- **Security lock can restrict access to instrument settings**
- **Weatherproof and corrosion-resistant, the compact RFI/EMI shielded, plastic case is suitable for process washdown; panel, pipe and wall mounting hardware is included**

A product of over sixty years of industrial pH experience, L&N's 7082 pH/ORP Analyzer offers many advanced features in a reliable and low-cost instrument. The monoplanar front panel incorporates a user-friendly display with specific word messages, and a clearly labeled keypad with tactile feedback. A security lock can restrict access to settings and calibration. Human engineering extends into the basic functioning of the analyzer to provide simple, foolproof operation. The highest levels of performance are attained through advanced analog and digital design.



Input to the 7082 may be from any L&N electrode system, using an appropriate preamplifier, or directly from a combination MEREDIAN® electrode in close proximity to the analyzer. Both glass antimony electrodes are accommodated.

L&N preamplifiers assure long term reliability under industrial conditions. Guarded, encapsulated circuitry maintains the high impedance electrode signal integrity even in dirty and humid conditions. The metallic preamplifier case completely shields the signal from electrical noise and additional circuitry protects the unit against nearby lightning strikes. Preamplifiers are specified as a part of electrode mountings.

Outputs from the 7082 are isolated from electrodes and from ground. This assures compatibility with recorders, programmable logic controllers, computers, distributed control systems, etc., with no possibility of ground-loop problems. The optional output signals of 0-1, 0-10V and 4-20 mA represent any pH range selected by the OUTPUT 1/OUTPUT 2 range limit key.

Proportional-only control, for batch neutralization systems, can be provided by the 7082 outputs. The OUTPUT 2 limit becomes the setpoint pH with 0% output signal. The OUTPUT 1 limit establishes the limit of proportional action with 100% output signal. Either acid or base reagents (oxidizing or reducing agents for ORP) may be used. The OUTPUT 1 setting automatically establishes the correct control action for the reagent depending on whether it is set above or below the setpoint

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Calibration uses a dedicated STD/SLOPE pushbutton for standardize and slope, permitting easy two-point calibration. Rechecking the standardize calibration after a slope adjustment is unnecessary since microprocessor calculations eliminate any interaction.

A HOLD function maintains output level and holds alarm action to prevent process upset when electrodes are removed from the process for calibration in buffer solutions. For "grab-sample" standardization, the displayed pH value is frozen at the time the sample is taken, for subsequent correction. The pH output and alarm/control action are also maintained during the grab-sample calibration procedure.

Alarms activate two SPDT relays within the Analyzer and may be allocated in any combination as high or low alarm/control points. Setpoints are digitally set with front-panel pushbuttons to any value with a resolution of 0.01 pH (1 mV). Deadband may be selected for 0.01, 0.05, 0.20 or 1.00 pH (1, 5, 20 or 100 mV).

Standard temperature compensation uses temperature information (provided by a sensor in the electrode) to correct for the change in the output of pH measuring electrodes. This is provided in virtually all pH instrumentation. However, standard compensation does not compensate for changes in solution pH with temperature, which is significant in high purity water.

Solution temperature compensation employs an additional algorithm unique to L&N microprocessor based Analyzers which allows the user to match the variation of solution pH with temperature of high-purity water. These effects are negligible in potable and waste waters. However, high-purity water and steam condensate have significant temperature coefficients as shown in Figure 1.

The solution temperature compensation algorithm in the 7082 permits measurement at any temperature, but displays the pH value referenced to 25 C. Most high-purity and steam power water chemistry specifications are referenced to 25 C. During calibration, the HOLD mode bypasses the algorithm to display unreferenced pH of the buffer solution, which has its own pH/temperature data identified on the container.

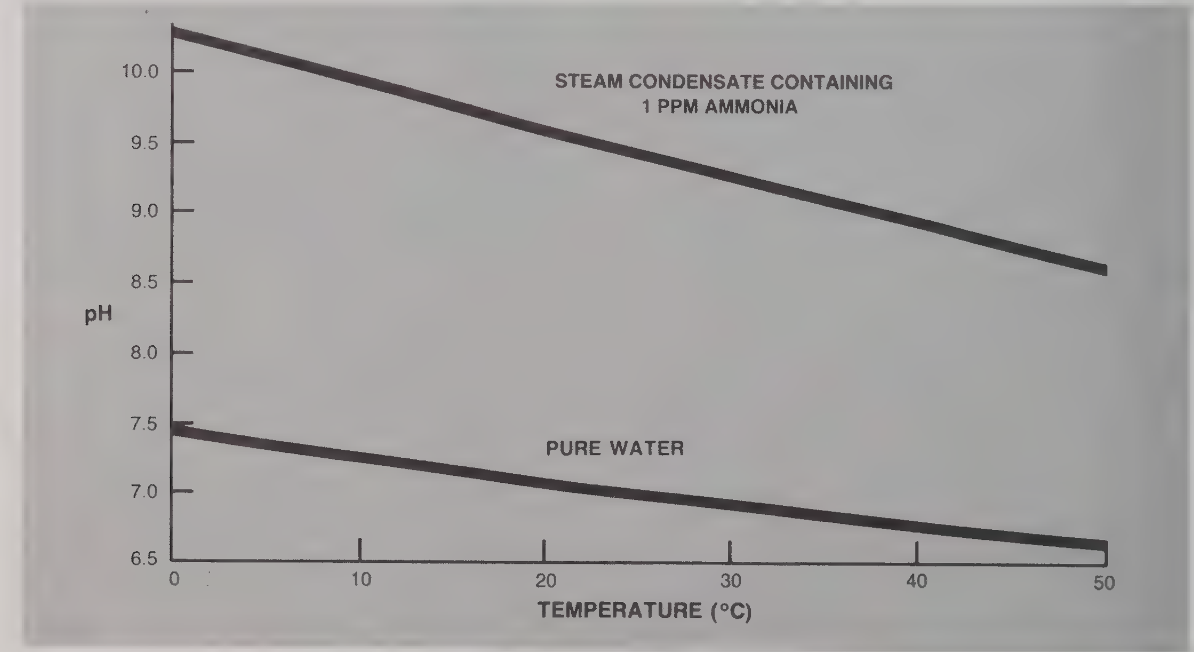


Fig. 1 pH vs. Temperature of Pure Water Samples.

Applications

Wastewater monitoring and control requirements can be satisfied with the 7082 Analyzer and MEREDIAN II Electrodes. This system is directly applicable to pH and ORP (redox) control of wastewater containing chrome and cyanide (see L&N Application Bulletins E1.1202-AB and E1.1204-AB, respectively), heavy metals precipitation and simple waste neutralization. This user-friendly Analyzer with quick disconnect MEREDIAN II single-probe electrode permits easy installation and operation.

High-purity water has a number of properties which make pH more difficult to measure than in most other applications. The 7082 Analyzer and 7773 stainless steel flow chamber provide the features necessary for reliable measurement. Specifically, the 7082 Analyzer provides unique adjustable solution temperature compensation (as previously described), to compensate for the effects shown in Figure 1. It allows display, alarm, control and recording of pH referenced to 25C. The 7773 electrode assembly provides shielding to prevent interference from electrical noise and streaming potentials.

Reverse osmosis system pretreatment relies on accurate pH monitoring and control to assure long and efficient membrane life. Carefully regulated acid addition prevents calcium scaling and deterioration of expensive membranes. The 7082 Analyzer/MEREDIAN II electrode system provides reliable measurement and alarming with 0.01 pH resolution.

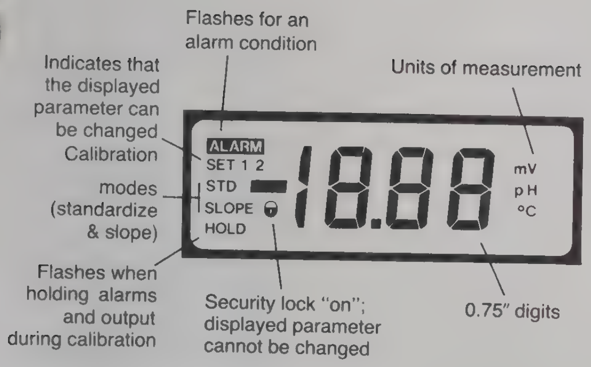

Flashes for an alarm condition
Indicates that the displayed parameter can be changed
Units of measurement
Calibration modes (standardize & slope)
ALARM
SET 1 2
STD
SLOPE
HOLD
-18.88
mV
pH
°C
Flashes when holding alarms and output during calibration
Security lock "on"; displayed parameter cannot be changed
0.75" digits

Fig. 2 7082 pH/ORP Analyzer Display.

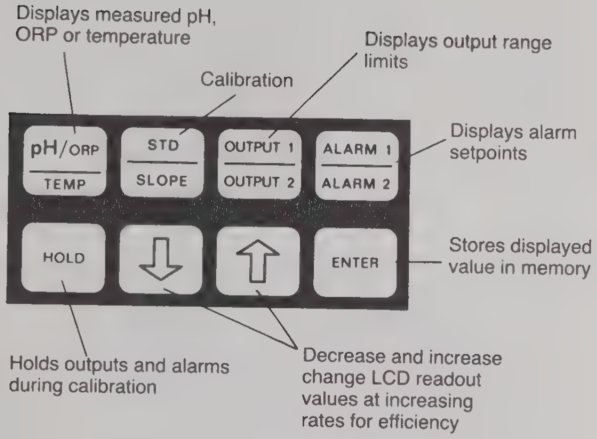

Displays measured pH, ORP or temperature
Calibration
Displays output range limits
Displays alarm setpoints
pH/ORP
TEMP
STD
SLOPE
OUTPUT 1
OUTPUT 2
ALARM 1
ALARM 2
HOLD
ENTER
Stores displayed value in memory
Holds outputs and alarms during calibration
Decrease and increase change LCD readout values at increasing rates for efficiency

Fig. 3 7082 pH/ORP Analyzer Keypad.

SPECIFICATIONS

Display 3½ digit, 0.75" high LCD. Displays pH/ORP, temperature, alarm conditions, alarm setpoints, calibration, output limits and diagnostics.

Display Ranges −2.00 to 14.00 pH or −1999 to 1999 mV and −10 to 130 C; Resolution 0.01 pH or 1 mV, 1C.

Output Range adjustable to any pH/mV range within the Display Range.

Keypad Monoplanar front panel with 8 keys. Pushbutton entry with tactile feedback.

Performance Under reference operating conditions
Accuracy: ±0.03 pH, or ±2 mV (display); 0.4% of span (output)
Drift: negligible
Repeatability: ±0.1% of span ±1 count
Reference Operating Conditions: 25±1C; 10-40% RH; 120 Vac

Operating Influences Under normal operating conditions
Effect on accuracy (% of span): Temperature, 0.05% /C; RH, <1%; Line Voltage, <0.1%/volt; Power Loss, memory retention by lithium battery, with low battery warning.

Operating Conditions Ambient Temperature: normal 0 to 60C, extreme −10 to 60C; storage −30 to 70C; Line Voltage: normal 108 to 132 Vac, extreme 100-132 Vac, 47-63 Hz; RH: 90% max. non-condensing at 40C max.

Output Signals Proportional to selected output range 7082-12 & -32: none.

7082-10 & -30: isolated 0-1Vdc, 200 ohms min. load; 10 Vdc, 2000 ohms min. load.

7082-11 & -31: 0-1V and 0-10 Vdc, and isolated 4-20 mA dc (600 ohms max load).

Alarms/Controls Two SPDT, Form C relays rated at 3A, 120 Vac, or 2A at 117 Vdc. Maximum switching power for ac, 125 Vac resistive; for dc, 60W resistive. Field configurable for high-high, low-low or high-low alarm/control activation. Deadband: 0.01, 0.05, 0.2, 1.0 pH or 1, 5, 20, 100 mV.

Temperature Compensation Conventional compensation for changing electrode output (Nernst response), plus selectable solution temperature compensation for high-purity water.

Power Requirements 108-132/216-264 Vac, 47-63 Hz, 15 VA; Memory retained by lithium battery when power is off.

Electrical Classification Suitable for Div 2 installation when relays are not used (or use 10V output to 7080 alarm module with Div 2 relays—see data sheet C12.1390-DS).

Case Gray Noryl plastic, NEMA 4X Rainproof and Outdoor. Interior Conductive coating to provide effective RFI/EMI shielding.

Case Dimensions 6⅛×6⅛×6" (156×156×152mm); panel cutout 5.53"×5.53" (141×141mm).

Weight 4 lbs. (1.8 kg).

Mounting Panel, surface and pipe mounting hardware supplied.

HOW TO ORDER

Order by 6-digit part number unless tagging is needed. If tagging is required, order by catalog number with the appropriate suffixes "A" and "B" as:

A B
7082-☐☐**-**☐☐☐ pH/ORP Analyzer

Suffix A:

pH input only from an L&N preamplifier, with:		
−10	isolated voltage outputs only	**056315**
−11	isolated voltage and isolated current outputs	**056316**
−12	no outputs	**056340**
pH or ORP input directly from L&N electrode with:		
−30	isolated voltage outputs only	**056317**
−31	isolated voltage and isolated current outputs	**056318**
−32	no outputs	**056341**

Note: Output options are not easily added in the field

Suffix B:

Optional Tagging (specify legend)

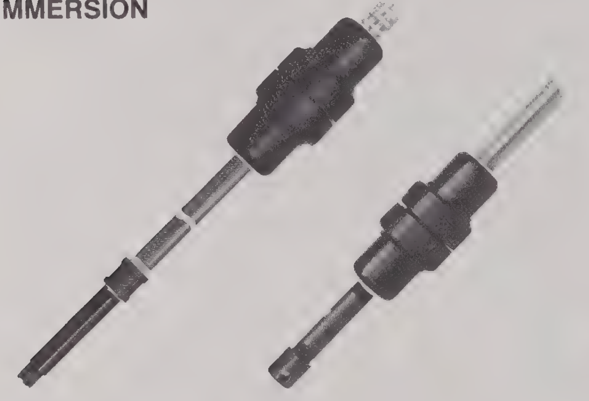
−206 1 linen tag, 23 characters max. on each of six lines
−207 1 aluminum tag, 15 characters max. on one line
−208 1 stainless steel tag, 25 characters max. on each of three lines

Accessory: Filler Plate Kit to mount a 7082 in an existing 7070, 7075 or 7076 panel cutout **056349**

pH/ORP Electrode Mountings

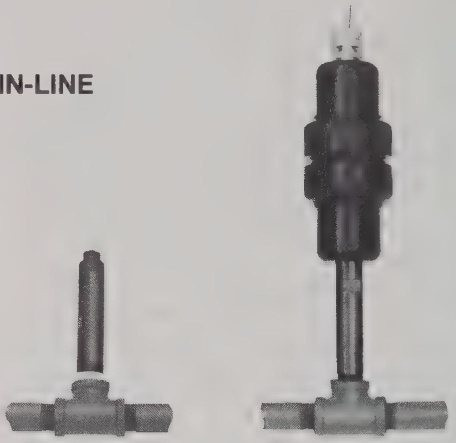
7777 with MEREDIAN® II Electrode

IMMERSION



- Single probe measuring & reference electrodes and temperature compensator
- Quick-disconnect electrode and preamplifier leads

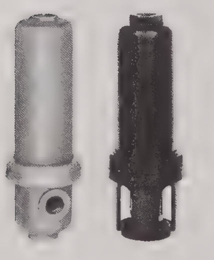
IN-LINE



- Flexible preamplifier location
- ¾″ MNPT connections — no O-rings

Data Sheet D2.1134-DS

7773



- Multi-electrode mounting accepts widest variety of electrodes
- For immersion or flow-through installation with ¾″ FNPT connections
- Wide choice of wetted materials: Polypropylene, Ryton or stainless steel for high-purity water measurement
- Ultrasonic cleaner optional

Data Sheet D2.1119-DS

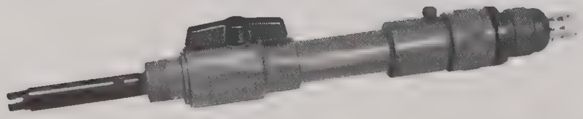
7779

- Self-cleaning in oily water
- Convenient ½″ NPT in-line mounting

Data Sheet D2.1118-DS

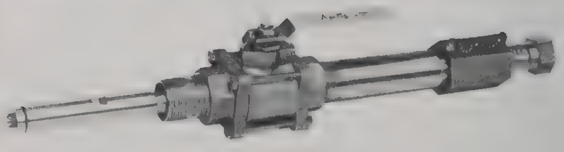
7774

CPVC



- Electrode removable from pressurized system
- Single probe includes measuring, reference electrode, and temperature compensator

STAINLESS STEEL



- Non-fouling electrode tips for hi-density paper stock
- 316 stainless steel or CPVC construction

Data Sheet D2.1133-DS

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7083 Microprocessor pH Analyzer

- **Exceptional versatility, accuracy and reliability for pH measurement and control**
- **All application-oriented options provided as standard features in one microprocessor-based model**
- **Highly visible customized liquid-crystal display (LCD) of pH, process temperature, set points, status messages**
- **Patented Electrolert warning against electrode failure or deterioration; can actuate "ELECTRODE FAIL" message display, horn and relays**
- **Extensive diagnostic program to continuously verify correct Analyzer operation and assist in troubleshooting**
- **Output triacs and relays, and external horn, activated by Alarm/Control/Failure, either by the process or diagnostics**
- **Isolated outputs proportional to pH span: 0-16, 0-20 or 4-20 mA, and 0-1 and 0-10 V, field-selectable**
- **Digitally-set range (with corresponding output); any span within 0.00 to 14.00 pH**
- **On-off control maintained during measurement interruption, based on continuous average of preceding cycles**
- **Direct one- or two-point calibration—standardization and slope—with no interaction**
- **Excellent RFI/EMI rejection**
- **Compact NEMA 4X weatherproof, corrosion-resistant, RF-shielded case**
- **Meets Class I, Division 2, Group B, C and D requirements**
- **Field-proven lightning-protected preamplifier for electrode mountings.**

The 7083, an advanced microprocessor-based pH Analyzer designed for use with L&N's industry-proven pH Preamplifer/Electrode Mountings, assures faster, more accurate, more reliable analysis and control in all types of pH applications.

Utilizing a superior combination of analog and digital techniques, the 7083 provides many unique innovations as standard features in one basic model.

These include

. . . a unique liquid-crystal display of the numerical values for measured pH, process temperature, set points, etc. with identifying legends, plus mode and status legends

7.00 pH
pH analyzer/controller
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. . . the unique Electrolert warning of measuring-electrode failure and/or breakage, or of reference-electrode deterioration; can actuate alarms or controls

. . . a unique diagnostic feature: continuous monitoring and verification of Analyzer operation, with a flashing display and optional audible alarm if failure occurs

. . . a unique control feature: average-duty operation, to provide continuing on-off control action during the calibration mode, or when an electrode failure occurs

. . . a unique application feature: solution-temperature compensation, where an accurate process-pH/temperature coefficient can be applied to the pH measurement, in addition to conventional temperature compensation for electrode output, and

. . . a built-in electrode-service timer, as a reminder to perform routine electrode maintenance on an optimum schedule.

Other significant features include

. . . clearly identified function selection, with dedicated pushbuttons on the front panel for pH and temperature display; adjustment of high and low settings for alarm and control; hold, standardize and slope functions; and numerical entry of digital values

. . . selectable isolated outputs corresponding to the selected pH span: 0-16, 0-20 or 4-20 mA, 0-1 and 0-10 V

. . . rugged, corrosion-resistant, weatherproof NEMA 4X case to protect the Analyzer from adverse environments—making it equally suitable for field-mounting or control-room use

. . . meets Class I, Division 2, Group B, C and D requirements for hazardous locations.

Preamplifier/Electrode System

The 7083 Analyzer is designed for compatibility with L&N's Preamplifier/Electrode Mountings. The environ-

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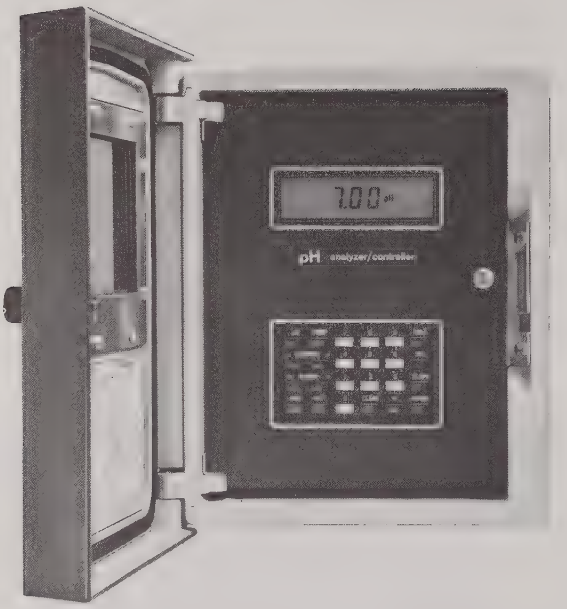
We put you in control.



mentally sealed, high-impedance preamplifier is located in (or adjacent to) the Electrode Mounting, with the measuring and reference electrodes and automatic temperature compensator.

Electrodes and compensator are directly connected to the preamplifier. A unique guarded circuit protects the input and provides a thousandfold decrease in sensitivity to leakage currents. The "guarded" preamplifier conditions and amplifies the electrode signal locally and transmits the low-impedance signal to the Analyzer over ordinary unshielded wire.

Signals can be transmitted over a distance of 6000 feet or more. The preamplifier/Analyzer system has high immunity to ground-loop "noise" and spurious RF signals. Grounded or ungrounded solutions can be measured, and no solution ground connection is required. The preamplifier is lightning-protected, which cannot prevent failure due to very near or direct strikes, but does provide substantial protection to the preamplifier itself by dissipating normally destructive surge currents through the electrodes.

Solution-temperature measurement (displayed on the LCD in degrees Celsius) is made by using the specially designed integral temperature compensator in the Electrode Mounting Assembly, saving the expense of a separate detector—and providing an easy check of buffer temperature during calibration.

Liquid-Crystal Display (LCD)

The liquid-crystal display, highly visible indoors or outdoors, provides direct readout of the numerical values for process pH and temperature, as well as for internal alarm/control set points. Legends simultaneously displayed to identify the numerical data include "pH", "°C", and "SET PT"; other legends indicate status or warnings, such as "HI/LO ALARM", "HI/LO CONTROL", "ELECTRODE FAIL", "ELECTRODE SERVICE", "STD", "SLOPE", "ERROR", etc. (Pressing the "TEST" pushbutton on the front panel brings all displays on the LCD simultaneously, for a display check.)

Electrolert Test

The patented Electrolert feature uses the microprocessor to monitor the performance of the pH measuring electrode for breakage, or for a complete loss of sample to the electrodes.

The Electrolert circuitry can also actuate triac or relay contacts, helping assure dependable pH control in critical processes where an electrode failure could result in poor quality of the final product, an out-of-control situation, the loss of an entire production run, or contamination of the product by broken electrode glass.

Operation of the Electrolert warning circuitry requires the use of L&N electrodes.

Alarms/Controls

Two triacs (solid-state relays) and two reed relays located within the Analyzer may be allocated, in any combination, as high or low alarm points and high or low control functions. Either normally open (NO) or normally closed (NC) operation is individually selectable (all contacts open on loss of power).

In general, triacs are used for devices with high inrush currents, such as solenoid valves and pump motors; reed relays are suitable for low-power devices, such as alarm lights and remote relays.

All alarm/control set points are digitally set with the front-panel pushbuttons to any value between 0.00 and 14.00 pH, in increments of 0.01 pH.

Calibration

Dedicated pushbuttons for standardize ("STD") and slope ("SLOPE") permit easy calibration and maintenance, since the microprocessor keeps each function separated, with no internal interaction—rechecking the "standardize" calibration after a "slope" change is unnecessary.

If electrodes are removed from the process for calibration in buffer solutions, the "HOLD" function provides the selected control and alarm operations. For "grab-sample" standardization, the displayed pH value is "frozen" at the time the sample is taken for subsequent correction; the pH output and control action are maintained during the grab-sample calibration procedure.

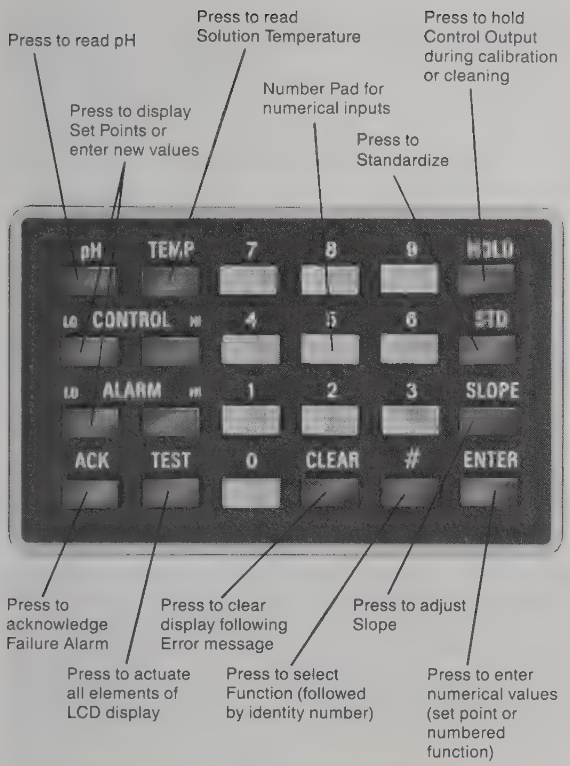
Solution-Temperature Compensation

Standard automatic temperature compensation uses temperature information (provided by the compensator in the Mounting) to correct only for the corresponding change in output of the measuring electrode. It does not, however, compensate for changes in *solution* pH with temperature.

When desired, a separate algorithm unique to the 7083 Analyzer allows the user to match the linear coefficient (for variation of solution pH with temperature) to a specific process.

With the algorithm operating, measurement is made at any temperature, but the pH value displayed is referenced to 25 C. By using the "HOLD" mode, the algorithm can be disabled so that true pH is displayed—and can be calibrated with buffer solution at any temperature.

This feature facilitates measurements in applications where long sample lines result in significant temperature variation of the sample (such as power-plant steam condensate), or in processes which require a specified pH at a reference temperature when process control is at an elevated temperature.


Press to read pH
Press to read Solution Temperature
Press to hold Control Output during calibration or cleaning
Press to display Set Points or enter new values
Number Pad for numerical inputs
Press to Standardize
pH
TEMP
7
8
9
HOLD
LO CONTROL HI
4
5
6
STD
LO ALARM HI
1
2
3
SLOPE
ACK
TEST
0
CLEAR
#
ENTER
Press to acknowledge Failure Alarm
Press to clear display following Error message
Press to adjust Slope
Press to actuate all elements of LCD display
Press to select Function (followed by identity number)
Press to enter numerical values (set point or numbered function)

Simplified pushbutton array on front panel (shown actual size) permits calling up pH and temperature readouts on LCD. . .accesses microprocessor for all calibrating, alarming and controlling functions.

Preventive Maintenance

As a reminder to clean, standardize or service the electrodes at a predetermined interval, the Analyzer features a service timer, which can be digitally set (from the front panel) at intervals from 1 hour to 125 days. When the time period has elapsed, the message "ELECTRODE SERVICE" appears in the LCD display.

For processes requiring very tight pH control, an electrode standardization limit may be set. If the total standardization correction required exceeds the preset limit, the "ELECTRODE SERVICE" message will again indicate the need for maintenance.

Average-Duty Operation

When the 7083 Analyzer is functioning as an on-off controller, and the pH measurement is interrupted for service or calibration, the Average-Duty operation feature, when selected, will assure uninterrupted control.

The Average-Duty Operation is accomplished by maintaining a running average of on-off control action, weighted toward the most recent operation. This continuously updated average is available whenever automatic operation is suspended, and may be activated whenever "ELECTRODE FAIL" or "HOLD" appears in the display.

Self Diagnostics

The microprocessor continuously checks the 7083 Analyzer for proper operation. If a failure occurs in the RAM or ROM memory, or in the battery-backup, or if there is excess electrical noise at the electrodes or in the wiring, an appropriate message (e.g., "FAIL 2") will appear on the LCD.

Failure Alarm

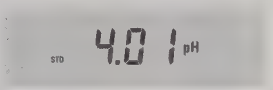
The Failure Alarm is an alarming mode comprising (1) a flashing display, on the LCD, of the specific alarm message, (2) a low-power output to an external horn, and (3) actuation of a triac or reed-relay output (optional). The Alarm is activated by electrode failure (detected by Electrolert) or Analyzer failure (detected by the self-diagnostics); it may also be programmed to alarm at the end of the Electrode Service interval, or when set points for the pH Alarm are exceeded.

The Failure Alarm is acknowledged by pressing the "ACK" button on the front panel, which shuts off the horn and relay, and stops the flashing of the message on the LCD . . . though the message remains until the problem is corrected.

Typical Customized Messages on Liquid-Crystal Display

ERROR FAIL #18
ELECTRODE
SERVICE STD
HOLD SLOPE
-18.88 pH
C
SET PT
LO HI
CONTROL
ALARM

All Elements Displayed ("TEST")

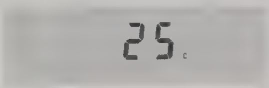


Standardize Calibration ("STD")

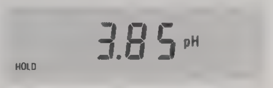
pH Measurement ("pH")

SLOPE
6.86 pH

Slope Calibration ("SLOPE")



Temperature Measurement ("TEMP")



Control Output Hold ("HOLD")

5.00 pH
SET PT
LO
ALARM

Low-Alarm Set Point ("LO" ALARM)

FAIL 2
10.03 pH

Battery-Backup Failure Condition

4.06 pH
LO
ALARM

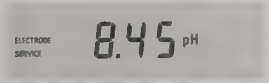
Low Alarm Condition

FAIL
ELECTRODE
2.68 pH

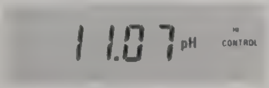
Electrolert Warning Condition

10.98 pH
SET PT
HI
CONTROL

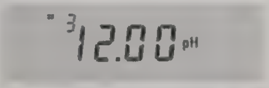
High-Control Set Point ("HI" CONTROL)


ELECTRODE
SERVICE
8.45 pH

Electrode Service-Requirement Condition


11.07 pH
HI
CONTROL

High Control Condition



Function #3: Output High End ("#, 3, Enter")

SPECIFICATIONS

Ranges For pH measurement and display: Any range and span, digitally set between 0.00 and 14.00 pH, with 0.01-pH resolution (no minimum span).

For solution-temperature measurement and display: −5 to +125 C, with 1-degree resolution.

LCD Display Liquid-crystal display (LCD) provides bold indication of pH or temperature values with half-inch-high, seven-segment, 3½-digit display—highly visible indoors or outdoors. Custom display also presents a variety of mode and status identifications for programming, standardizing, alarming, etc.

Performance Under reference operating conditions.

Accuracy: pH Display, ±0.02 pH; pH Voltage Output, ±(0.02 pH + 0.1% of span); pH Current Output, ±(0.02 pH + 0.2% of span).

Output Resolution: 0.01 pH.

Drift: ±0.01 pH, over one month.

Response Time: pH value on display is updated every second.

Reference Operating Conditions: Ambient temperature, 25 C; 120 or 240 V, 50-60 Hz; less than 50% RH; nominal electrode resistance; no EMI.

Operating Influences Under normal operating conditions.

Effect on Accuracy: Temperature influence, less than 0.0015 pH per degree C, in displayed pH value. Line Voltage Influence, ±0.001 pH per 1% change in supply voltage. Electromagnetic Interference (EMI), less than 1% change for field strength of 10 V/m at 20-30 MHz and 150-160 MHz, with all connections in grounded metal conduit; meets SAMA Std 33.1, Classification 2-ab. Relative humidity, ±0.1 pH, over 0-95% RH.

Power loss: Battery backup will maintain calibration, set points and adjustments in microprocessor memory for at least 8 hours.

Normal Operating Conditions: Ambient temperature, −10 to +50 C (14 to 122 F); storage, −40 to +60 C (−40 to 140 F); 100-132 or 200-264 V, 47-63 Hz; 95% RH max., non-condensing, at 40 C max.

Outputs Proportional to selected pH range. 7083-10: non-isolated voltage outputs only; 7083-11: isolated voltage and current outputs. Voltage outputs: 0-1 V d-c (5 megohm minimum load impedance) and 0-10 V d-c (2000 ohm minimum).

Isolated Current Output: 0-16 mA (1150 ohms, max.), 0-20 or 4-20 mA (900 ohms, max.), field-selectable.

Note: 7083-11 outputs are isolated from ground and from input but are not isolated from each other.

Failure Alarm Diagnostic circuitry continuously monitors electrode condition and Analyzer performance; a message appears in the LCD when failure occurs (with optional audible alarm and/or triac or relay action). An Acknowledge ("ACK") button on the keyboard disables the alarm actions, but the message remains (without flashing) until the condition is corrected.

Horn Output A 15-V d-c, 10-mA signal is available at the terminals (under alarm conditions) to energize a low-power sound device (such as a separately-ordered L&N Part Number 021855). This output is triggered by the Failure Alarm, independent of triac or relay operations.

Display and Programming Keyboard Comprises a bank of 24 keys compactly mounted on the front panel, beneath the LCD; 10 blue keys provide a number pad ("0" to "9"), permitting digital inputs and programming; 14 black keys call up various displays, enter digital values, initiate standardizing, etc.

Electrolert Protection Measuring electrode is automatically tested every 10 seconds. In all operating modes except "STD" and "SLOPE", an LCD display of "ELECTRODE FAIL" indicates a broken electrode or loss of sample—can actuate Failure Alarm, with or without triac or relay operation. While calibrating in "STD" mode, "ELECTRODE SERVICE" display indicates excessive electrode drift and need for reference-electrode replacement. While calibrating in "SLOPE" mode, same display indicates measuring-electrode deterioration and need for replacement.

Alarms/Controls Two triacs and two reed relays, with operation activated by alarm points, control set points or the Failure Alarm, as selected independently by internal jumpers.

Triacs: SPST, failsafe control, optically isolated. Rating, 3 A max., 50 mA min., on 100-240 V a-c. Operation ("NO" or "NC") set by separate jumpers for each. Contacts open on loss of power.

Relays: SPST. Rating, 10 W (4 W inductive), 0.5 A, 135 V a-c or 200 V d-c, max. (Product of voltage and current cannot exceed 10 W resistive). Operation ("NO" or "NC") set by separate jumpers for each. Contacts open on loss of power.

Deadband The deadband of alarms/controls is adjustable, with 0.01 pH resolution.

Temperature Compensation Automatic only, provided by compensator in electrode mounting assembly.

Power Requirements 100-132 or 200-264 V (switch-selected operation), 47-63 Hz, 15 VA.

Electrical Classification Suitable for non-hazardous and Class I, Division 2, Group B, C and D locations.

Case and Door Rugged gray Noryl case, NEMA 4X and 3R; ANSI C39.5 Enc. 4 and 5 (weatherproof, corrosion-resistant, dust-tight, outdoor). RF shielding in interior of case.

Case Dimensions Overall: 9⅛" (w) x 10¾" (h) x 7⅛" (d) (231 x 273 x 181 mm). Behind front surface of a panel: 7⅛" (w) x 9¾" (h) x 5⅞" (d) (181 x 248 x 149 mm).

Weight 12 lb (5.5 kg).

Mounting Hardware furnished to panel-, surface- or pipe-mount the Analyzer.

HOW TO ORDER

Specify Catalog Number 7083-A-B, with appropriate suffixes. (Model 7083-11-000 is stocked as Part Number 044209)

Suffix A. Outputs	
Non-Isolated Voltage Outputs only (0-1 and 0-10 V)	**10**
Isolated Voltage Plus Isolated Current Outputs	**11**
Suffix B. Tagging (Specify Legend)	
None	**000**
1 Metalcal Label, 15 Characters Max. on Each of Two Lines	**205**
1 Linen Tag, 23 Characters Max. on Each of Six Lines	**206**
1 Aluminum Tag, 15 Characters Max. on One Line	**207**
1 Stainless Steel Tag, 25 Characters Max. on Each of Three Lines	**208**
Same as "208", but Permanently Mounted on Case	**209**

An 021855 Signal Horn (2700 Hz, 95 dBA; 1½" x 3½" dia. (38 x 89 mm dia.), for operation from the Failure-Alarm terminals, should be separately ordered.

LEEDS & NORTHRUP North Wales, PA 19454
A UNIT OF GENERAL SIGNAL

We put you in control.

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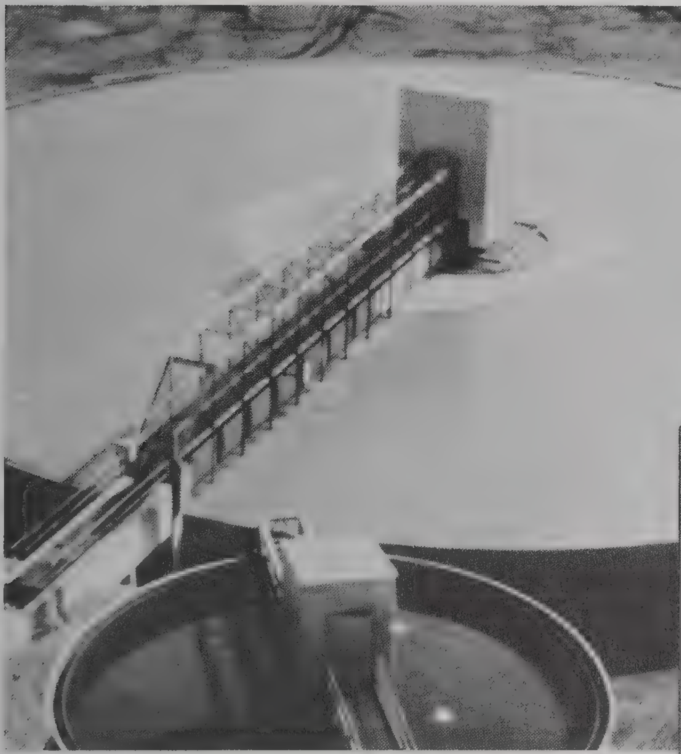
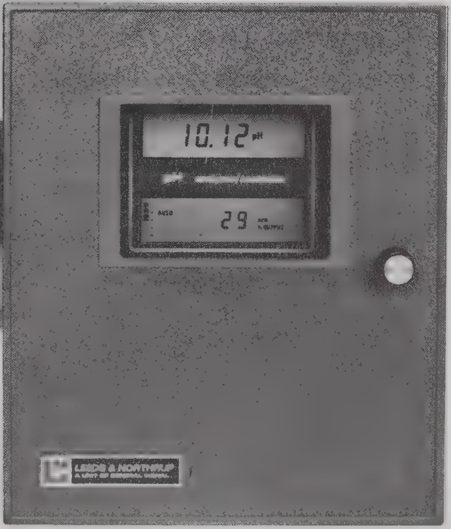
7084 Microprocessor pH Analyzer/Controller





CONTROL FEATURES:

- Unique characterization of pH to match process-titration curve, for more accurate proportioning control
- Field-selectable C.A.T. (Current-Adjusting Type), D.A.T. (Duration-Adjusting Type) or P.F.T. (Pulse-Frequency Type) single or dual control outputs, compatible with most end-elements
- Field-selectable feedback (PID), feedforward (open-loop) or adaptive (feedforward/feedback) control configurations
- Two triacs and three reed relays available for individual dedication to alarms or control action, and separate output for audible alarm
- Internal linearization of flow-transmitter signal (e.g., square-root extraction) for inclusion in proportioning-control algorithm
- Final control-element compensation for linear and equal-percentage devices

MICROPROCESSOR FLEXIBILITY

- Microprocessor-based for exceptional versatility, accuracy, reliability
- Extensive self-diagnostic programs, for continuous verification of correct operation of Analyzer and associated equipment, and to assist in troubleshooting
- Security code, user-selectable, restricts access to certain adjustments
- Non-volatile memory for reliable performance: no batteries

OPERATIONAL FEATURES:

- One universal model to provide a wide variety of analysis and control techniques
- Exclusive Electrolert™ detection of electrode failure or deterioration to actuate an external audible alarm signal, "ELECTRODE FAIL" message, and relay(s)
- pH (or redox), temperature and flow measurements
- Meets Class I, Division 2, Group B, C and D requirements
- Highly visible customized digital display (LCD) of all parameters, settings, and status messages
- Digitally-set range limits for output (e.g., 6.50 to 9.75) within 0.00 to 14.00 pH
- Direct non-interacting one- or two-point calibration: standardization (zero) and slope (span) adjustment
- Isolated voltage output for remote recording
- Excellent RFI/EMI rejection
- Compact NEMA 4X weatherproof, corrosion-resistant case
- Utilizes lightning-protected preamplifier/electrode mountings

LEEDS & NORTHRUP
A UNIT OF GENERAL SIGNAL

Instrument & System Solutions!

The 7084, a unique microprocessor-based Analyzer/Controller designed for use with L&N's industry-proven Preamplifier/Electrode Mountings, assures faster, more accurate, more reliable analysis and control in all types of pH (or redox) applications. This universal Analyzer/Controller provides measurement plus proportioning control, in feedback, feedforward or adaptive configurations. And Current-Adjusting Type (C.A.T.), Duration-Adjusting Type (D.A.T.) for solenoid valves, and Pulse-Frequency Type (P.F.T.) for pulse-input metering pumps are all available from a single unit.

Utilizing a superior combination of analog and digital techniques, the 7084 provides many unique innovations as standard features in one basic model.

These include

. . . two unique liquid-crystal displays of the numerical values for measured pH, flow rate, process temperature, set points, etc., with identifying legends, plus mode and status legends for measuring and control functions

. . . the unique Electrolert warning of measuring-electrode failure and/or breakage, or of reference-electrode deterioration; can actuate an alarm, or take failsafe control action

. . . a unique self-diagnostic feature: continuous monitoring and verification of the operation of the Analyzer/Controller and associated equipment, with a flashing display and optional audible alarm if failure occurs

. . . a unique application feature: solution-temperature compensation, where an accurate process-pH/temperature coefficient can be applied to the pH measurement, in addition to conventional temperature compensation for electrode output

. . . an exclusive L&N design innovation: characterization of pH to match the process titration curve, which stabilizes gain and permits a precision of control never before possible, regardless of the set point; where composition (and titration curve) changes predictably, an alternate characterization curve may be selected locally or by remote contacts

. . . a built-in electrode-service timer, as a reminder to perform routine electrode maintenance on an optimum schedule.

Other significant features include

. . . clearly identified function selection, with dedicated pushbuttons on the front panel for pH (or redox), temperature and flow-rate display; adjustment of alarm and control set-points; alarm-hold, standardize and slope functions; and numerical entry of digital values

. . . display of alarm conditions for high and low pH, which can actuate triac(s) or relay(s); alarms for temperature and flow are not displayed, but can also actuate triac(s) or relay(s)

. . . selectable isolated output: 0-16, 0-20 or 4-20 mA, corresponding to the selected pH range or for the C.A.T. control output; 0-1 or 0-10 V, corresponding to the selected pH range, for recording

. . . choice of control: C.A.T., providing an isolated current output for single or split-range feeders and separate terminals for two full-range feeders; D.A.T., using one or two triacs; P.F.T., using one or two reed relays and built-in current-to-frequency conversion for pulse input to electronic metering pumps—saving cost, simplifying installation and improving reliability; unused triacs or relays can be dedicated to alarms

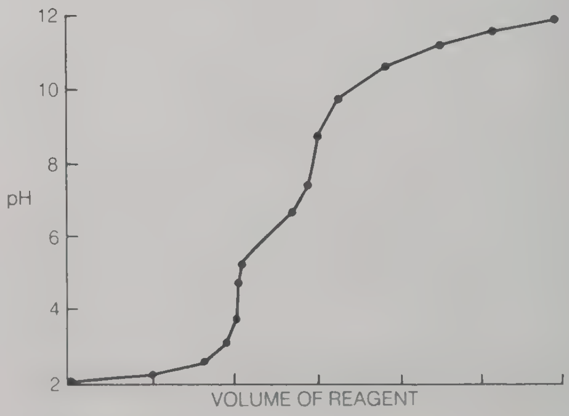
. . . acceptance of a variety of 4-20 mA input signals: (a) from a two-wire pH or redox transmitter (externally powered) in place of a preamplifier signal, to meet intrinsically safe or explosion-proof requirements (b) from an isolated flow transmitter (externally powered), for inclusion in the proportioning-control algorithm (c) a remote isolated set-point signal corresponding to 0-14 pH range, or a set-point bias signal for cascade control, corresponding to a −4 to + 4 pH bias range (with failsafe to local set point)

. . . optional remote transfer from automatic to manual control by isolated contact closure, holding output at the last value or switching to a preset value

. . . user-selected security code to restrict access to selected adjustments

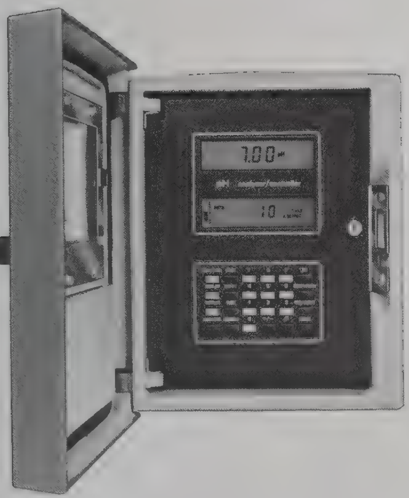
. . . non-volatile memory, without batteries, to retain all programmed values in case of power loss

. . . selectable linear or equal-percentage control-valve compensation for the non-linear relationship of input to flow for ball, butterfly and equal-percentage plug valves.



Segment Characterization In this typical graph, the plotted points have been selected from the titration data of an acid process neutralized by sodium carbonate. Up to 16 such data points can be entered directly into the memory of the 7084 Analyzer/Controller via the front-panel keyboard. As the measured pH varies, the 7084 tracks the linear segments between points, characterizing the pH-vs-reagent demand.

Note that spacing between points can be selected to maximize the conformity to any titration-curve shape; multiple inflection points are easily accommodated.



Preamplifier/Electrode System

The 7084 Analyzer/Controller is designed for compatibility with L&N's Preamplifier/Electrode Mountings. The environmentally sealed, high-impedance preamplifier is located in (or adjacent to) the Electrode Mounting, with the measuring and reference electrodes and automatic temperature compensator.

Electrodes and compensator are directly connected to the preamplifier. A unique guarded circuit protects the input and provides a thousandfold decrease in sensitivity to leakage currents. The "guarded" preamplifier conditions and amplifies the electrode signal locally and transmits the low-impedance signal to the Analyzer over ordinary unshielded wire.

Signals can be transmitted over a distance of 6000 feet or more. The preamplifier/Analyzer system has high immunity to ground-loop "noise" and spurious RF signals. Grounded or ungrounded solutions can be measured, and no solution ground connection is required. The preamplifier is lightning-protected, which cannot prevent failure due to very near or direct strikes, but does provide substantial protection to the preamplifier itself by dissipating normally destructive surge currents through the electrodes.

Electrolert Test

The patented Electrolert feature uses the microprocessor to monitor the performance of the pH measuring electrode for breakage, or for a complete loss of sample to the electrodes.

The Electrolert circuitry can also actuate triac or relay contacts, helping assure dependable pH control in critical processes where an electrode failure could result in poor quality of the final product, an out-of-control situation, the loss of an entire production run, or contamination of the product by broken electrode glass.

Operation of the Electrolert warning circuitry requires the use of L&N electrodes.

Self Diagnostics

The microprocessor continuously checks the 7084 Analyzer/Controller for proper operation. If a failure occurs in the RAM or ROM memory, or with an incoming 4-20 mA signal, or if there is excess electrical noise at the electrodes or in the wiring, an appropriate message (e.g., "FAIL 2") will appear on the LCD.

Failure Alarm

The Failure Alarm is an alarming mode comprising (1) a flashing display, on the LCD, of the specific alarm message, (2) a low-power output to an external horn, and (3) actuation of a triac or reed-relay output (optional). The Alarm is activated by electrode failure (detected by Electrolert) or Analyzer failure (detected by the self-diagnostics); it may also be programmed to alarm at the end of the Electrode Service interval, or when set points for the pH Alarms are exceeded.

Electrolert optional failsafe action can transfer the controller to manual operation on electrode failure, either to a preset output or to hold the last reliable output. This transfer is indicated by "MAN" flashing in the lower LCD display.

The Failure Alarm is acknowledged by pressing the "ACK & CLR" button on the front panel, which shuts off the horn and relay, and stops the flashing of the message on the LCD . . . though the message remains until the problem is corrected.

Solution-Temperature Compensation

Conventional automatic temperature compensation uses temperature information (provided by the compensator in the Mounting) to correct only for the corresponding change in output of the measuring electrode. It does not, however, compensate for changes in *solution* pH with temperature.

Solution-temperature compensation in the 7084 allows the user to compensate for this variation in any process.

With this feature, measurement is made at any temperature, but the pH value displayed is referenced to 25 C. By using the "HOLD" mode, the feature is disabled so that true pH is displayed—and can be calibrated with buffer solution at any temperature.

This feature facilitates measurements in applications where long sample lines result in significant temperature variation of the sample (such as power-plant steam condensate), or in processes which require a specified pH at 25 C when process control is at an elevated temperature.

Preventive Maintenance

As a reminder to clean, standardize or service the electrodes at a predetermined interval, the Analyzer features a service timer, which can be digitally set (from the front panel) at intervals from 1 hour to 125 days. When the time period has elapsed, the message "ELECTRODE SERVICE" appears in the LCD display.

For processes requiring very tight pH control, an electrode standardization limit may be set. If the total standardization correction required exceeds the preset limit, the "ELECTRODE SERVICE" message will again indicate the need for maintenance.

Calibration

A dedicated pushbutton for standardize and slope ("STD/SLOPE") permits easy calibration and maintenance, since the microprocessor keeps each function separate, with no interaction—rechecking the "standardize" calibration after a "slope" change is unnecessary.

If electrodes are removed from the process for calibration in buffer solutions, the "HOLD" function prevents change of the alarm condition. For "grab-sample" standardization, the displayed pH value is "frozen" at the time the sample is taken for subsequent correction; the pH output and control action are maintained during the grab-sample calibration procedure.

ANALYZER/CONTROLLER CONFIGURATIONS

Four basic configurations, field-selectable, can be accommodated by the 7084 Analyzer/Controller:

1. **Feedback Analyzer/Controller** The feedback Analyzer/Controller combines a characterized pH signal, a linearized flow signal (when available) and a pH set point. (The 4-20 mA flow signal can be internally linearized by the proper selection of a 1/2, 1, 3/2 or 5/2-power algorithm to accommodate orifice, magnetic, flume or weir-type transmitters.) Pushbuttons on the front panel provide digital three-mode (proportional, reset, rate) control tuning for feedback control. Automatic-to-manual and manual-to-automatic transfers are bumpless. Full- or split-range final control elements can be used. Flow compensation is provided for varying process-flow rates.

Combining pH, temperature and flow indication with full-proportioning pH control in a single case

. . . permits mounting outdoors, near the electrodes, to reduce maintenance time and simplify tuning

. . . eliminates the need for separate mounting of individual control devices, saving installation time and cost

. . . reduces the number of electrical connections and the external wiring required, and

. . . maximizes operator familiarity with the operation of the pH measurement and control functions.

Two feedback controllers can be combined to provide cascade control for slow reactions, such as neutralization with lime. The control output of the primary downstream controller (operating with local set point) provides the set point (or biases the local set point) of the secondary upstream controller, whose control output actuates the feeder(s).

2. **Feedforward Analyzer/Controller** The open-loop feedforward Analyzer/Controller combines a characterized pH input signal, a linearized flow signal and a pH set point, in a proportional-plus-lag control algorithm.

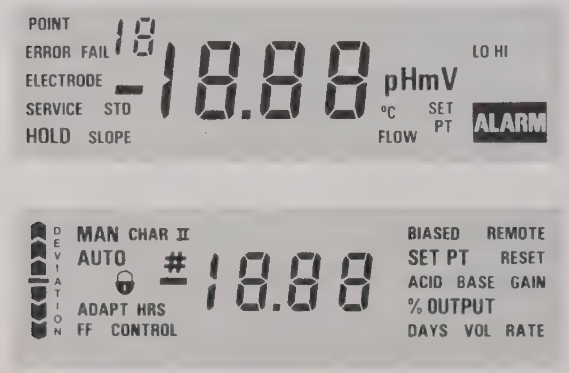
Transfer from automatic to manual control is bumpless. Control action is reversible. Full- or split-range final control elements (feeders) can be used.

Open-loop feedforward-control accuracy depends on consistent matching of the process-titration curve (characterization). Where this is difficult or impractical, the compensating action provided by an additional feedback control loop, or an adaptive configuration, is recommended. This configuration is not suitable for redox control.

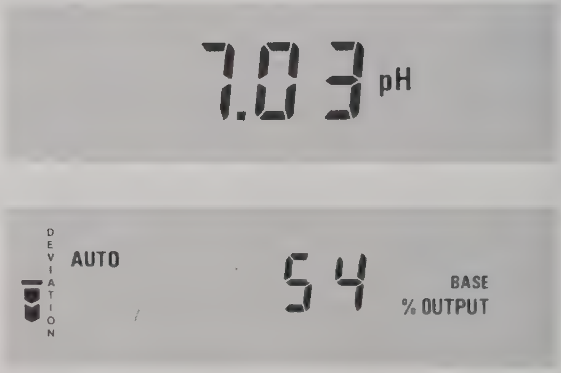
3. **Adaptive Analyzer/Controller** The adaptive Analyzer/Controller is located downstream from a feedforward controller. The control output from the feedforward controller is adapted by the downstream controller to develop the final control output to the reagent feeder(s). This arrangement combines the fast response of feedforward control with fine adjustment of feedback control to satisfy the more demanding pH control requirements. This configuration is not suitable for redox control.

4. **Analyzer/Controller with Characterized pH Output Signal** In this configuration, the 7084, in its NEMA 4X case, may be installed near the electrodes to facilitate calibration, while a separate controller may be remotely located in a central control room. The 7084 linearizes the pH-vs-reagent demand of the process stream being controlled, and the characterized output (displayed as 0-100% on the lower LCD) is an isolated current used as the input to the separate conventional three-mode controller.

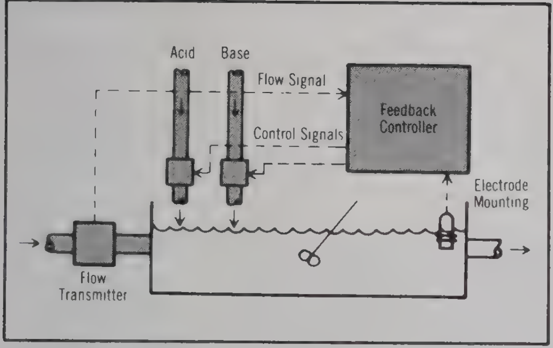
Liquid-Crystal Displays



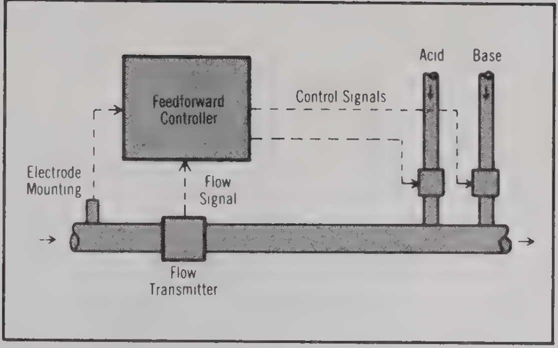
Test: All elements of both displays (shown actual size) can be brought up for a check. Values, legends, etc. in the upper display are primarily associated with measurement, alarms and diagnostics; in the lower display, with control operation.



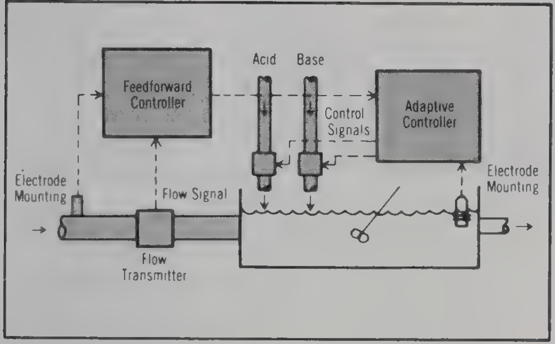
Operating Displays: In these typical operating displays for a feedback configuration, the upper display shows the pH measurement. The low display indicates a deviation below set point, between 0.3 and 0.99 pH (one, two or three arrows indicate ≥0.1, ≥0.3 or ≥1.0 pH); automatic control; and output at 54% of base feed capacity.


Acid
Base
Flow Signal
Feedback Controller
Control Signals
Electrode Mounting
Flow Transmitter

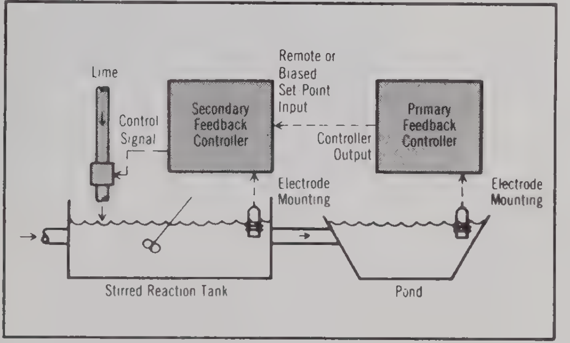
For *feedback* control, the 7084 Analyzer/Controller receives its pH signal from electrodes located downstream from the reagent feed point; characterization of pH, flow compensation (when used) and three-mode adjustments (proportional, reset, rate) provide precise control.


Acid
Base
Feedforward Controller
Control Signals
Electrode Mounting
Flow Signal
Flow Transmitter

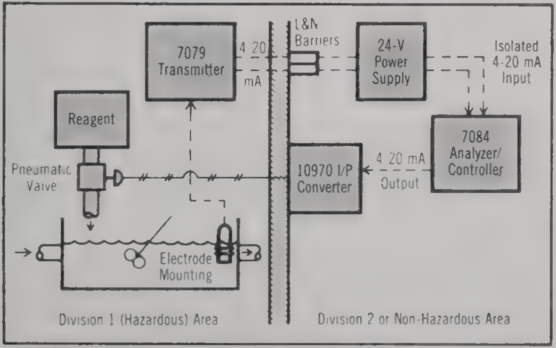
For *feedforward* (open-loop) control, the 7084 receives its pH signal from electrodes located upstream from the reagent feed point; proportional plus lag control modes provide fast response, but accuracy depends on consistently matching the process titration curve (characterization).


Feedforward Controller
Acid
Base
Adaptive Controller
Control Signals
Electrode Mounting
Flow Signal
Electrode Mounting
Flow Transmitter

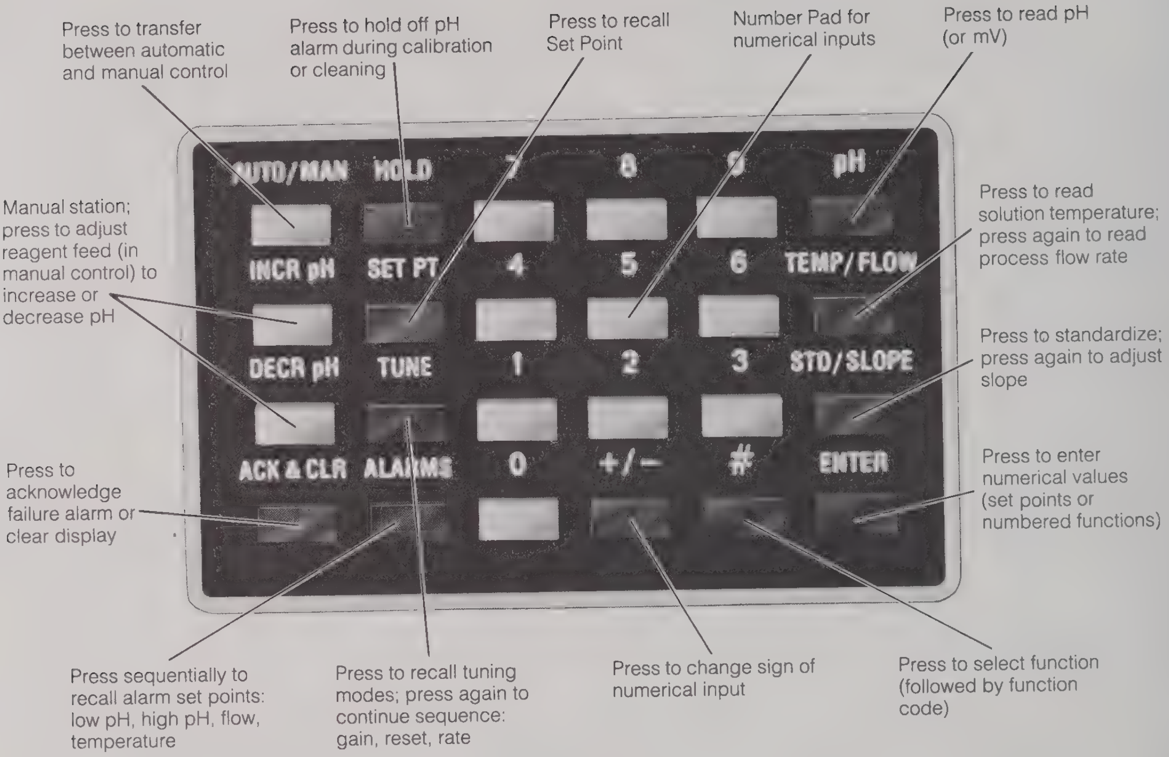
For *adaptive* control, two 7084 Analyzer/Controllers are used: a feedforward controller, with its electrodes upstream from the reagent feed point, and an adaptive controller, with its electrodes downstream from the feed point. The control signal from the feedforward controller is adapted by the downstream controller to operate the feeders, combining fast response with precise adjustment.


Lime
Control Signal
Secondary Feedback Controller
Remote or Biased Set Point Input
Controller Output
Primary Feedback Controller
Electrode Mounting
Electrode Mounting
Stirred Reaction Tank
Pond

For *cascade* control, two feedback 7084 Analyzer/Controllers are used. In a typical lime neutralization process, electrodes for the secondary controller are located in stirred reaction tank, where the lime is added; electrodes for the primary controller are located downstream, in the pond. Control output from the primary controller provides the set point (or biases the set point) of the secondary controller, to compensate for the slow reaction of the lime after leaving the reaction tank.


7079 Transmitter
4 20 mA
L&N Barriers
24-V Power Supply
Isolated 4-20 mA Input
Reagent
Pneumatic Valve
10970 I/P Converter
4 20 mA Output
7084 Analyzer/Controller
Electrode Mounting
Division 1 (Hazardous) Area
Division 2 or Non-Hazardous Area

Intrinsically-Safe Operation For applications where the point of measurement in a process is located in a Division 1 (hazardous) area, intrinsically safe operation can be assured through the use of a 7079 pH (or Redox) Two-wire Transmitter, with L&N Energy-Limiting Barriers, transmitter Power Supply and the 7084 Analyzer/Controller located in a Division 2 or non-hazardous area. The 4-20 mA control output from the 7084 operates the final control device, such as a 10970 Electro-Pneumatic Converter regulating a pneumatic valve


Press to transfer between automatic and manual control
Press to hold off pH alarm during calibration or cleaning
Press to recall Set Point
Number Pad for numerical inputs
Press to read pH (or mV)
Manual station; press to adjust reagent feed (in manual control) to increase or decrease pH
Press to read solution temperature; press again to read process flow rate
Press to standardize; press again to adjust slope
Press to acknowledge failure alarm or clear display
Press to enter numerical values (set points or numbered functions)
AUTO/MAN
HOLD
7
8
9
pH
INCR pH
SET PT
4
5
6
TEMP/FLOW
DECR pH
TUNE
1
2
3
STD/SLOPE
ACK & CLR
ALARMS
0
+/−
#
ENTER
Press sequentially to recall alarm set points: low pH, high pH, flow, temperature
Press to recall tuning modes; press again to continue sequence: gain, reset, rate
Press to change sign of numerical input
Press to select function (followed by function code)

Simplified pushbutton array on front panel (shown actual size) permits calling up pH, temperature and flow readouts on the LCD . . . accesses the microprocessor for all calibrating, alarming and controlling functions.

SPECIFICATIONS

Ranges For pH measurement and display: Any range, digitally set between 0.00 and 14.00, with 0.01 pH resolution (see "Outputs", below).

For redox: Any range, digitally set between −1000 and +1000 mV, with 1-mV resolution.

For solution temperature: −10 to +140 C, with 1-degree resolution.

For flow: 0 to 1999 flow units, as defined by the user, with 1-unit resolution (typical).

LCD Displays Two customized liquid-crystal displays provide numerical values in seven-segment, 3½-digit displays, and a variety of mode and status identifications for programming, standardizing, alarming, etc., highly visible indoors or outdoors. The upper display presents data primarily associated with measurements; the lower display, with control operation.

Performance Under reference operating conditions. Accuracy: pH Display, ±0.02 pH; pH Voltage Outputs, ±(0.02 pH + 0.1% of span); pH Current Output, ±(0.02 pH + 0.2% of span). Temperature Display, ±1 C (±2 C, above 120 C). Flowrate Display, ±0.5% of span or 1 flow unit, whichever is greater (typical).

Response time: pH value on display is updated every second.

Reference Operating Conditions: Ambient temperature, 25 C; 120 or 240 V, 50-60 Hz; less than 50% R.H.

Operating Influences Under normal operating conditions. Effect on Accuracy: Temperature Influence on pH value, less than 0.0015 pH per degree C; on pH voltage output, less than 0.005% per degree C on zero, less than 0.01% per degree C on span. Line-Voltage Influence, less than ±0.001 pH per 1% change in supply voltage. Relative Humidity Influence, ±0.1 pH, over 0-95% R.H.

Power Loss: No effect on set points, tuning, calibration, etc., whose values are in non-volatile memory.

Normal Operating Conditions: Ambient temperature limits, −10 to +50 C (14 to 122 F); storage temperature limits, −40 to +60C (−40 to 140 F); 100-132 or 200-264 V, 47-63 Hz; 95% R.H. max., non-condensing at 50° C max.

Inputs
pH: (a) pH and temperature signals from L&N Preamplifier/Electrode Mounting, or (b) pH signal (4-20 mA/0-14 pH) from 7079-11 or 7079-33 Two-wire pH Transmitter.*

Redox: (a) Redox signal from L&N Preamplifier/Electrode Mounting, or (b) isolated redox signal (4-20 mA/0-1000 mV) from 7079-22 Two-wire Redox Transmitter.*

Flow: Isolated flow signal (4-20 mA) from flow transmitter.*

Feedforward Input: 4-20 mA isolated signal from feedforward 7084 Analyzer/Controller into adaptive controller.

Set-Point Input: 4-20 mA isolated signal from primary controller for cascade control, or from a process programmer or computer.

Input Impedance: For all 4-20 mA inputs, 25 ohms.

Outputs
Isolated Voltage: 0-1 V d-c (5-megohm minimum load impedance), or 0-10 V d-c (2000-ohm minimum), jumper-selected, proportional to selected pH (or redox) range.

Isolated Current: 4-20 or 0-20 mA d-c (900-ohm maximum load), or 0-16 mA d-c (1150-ohm maximum), jumper-selected, proportional to selected pH (or redox) range.

**Note: (1) Transmitters cannot be powered from the 7084 Analyzer/Controller; (2) Electrolert and temperature-compensation functions require signals directly from an L&N Preamplifier/Electrode Mounting.*

Note: Voltage and current outputs are isolated from inputs, but are not isolated from each other. Only one output signal may be grounded.

Current output is available for either C.A.T. control or pH signal, NOT both.

Failure Alarm: Diagnostic circuitry continuously monitors electrode condition and Analyzer/Controller performance; a message flashes in the upper LCD when failure occurs (with optional horn and/or triac or relay action).

An Acknowledge ("ACK/CLR") button on the keyboard silences the horn and reverses triac or relay action, but the message remains (without flashing) until the condition is corrected.

Horn Output A 15-V d-c, 10-mA signal is available at the terminals (under failure conditions) to energize a low-power sound device (such as separately-ordered L&N Part Number 021855). This output is triggered by the Failure Alarm, independent of the triac or relay operations.

Display and Programming Keyboard Comprises a bank of 24 keys, compactly mounted on the front panel, beneath the LCDs; 11 keys provide a number pad ("0" to "9", and "+/−"), permitting digital inputs and programming; 13 keys call up various displays, enter digital values, switch from automatic to manual control, initiate standardizing, etc.

Electrolert Protection Measuring electrode is continually monitored by the microprocessor. In all operating modes except "STD" and "SLOPE", display of "FAIL ELECTRODE" indicates a broken electrode or loss of sample within 10 seconds—can actuate Failure Alarm, with or without initiating failsafe control and triac or relay operation.

While calibrating in "STD" mode, "ELECTRODE SERVICE" display indicates excessive electrode drift and need for reference-electrode replacement. While calibrating in "SLOPE" mode, "ELECTRODE SERVICE" indicates measuring-electrode deterioration and need for replacement.

Alarms/Controls Two triacs and three reed relays available, with operation activated by alarms, control action, or the Failure Alarm, as selected by function settings. Triacs: Two, SPST, failsafe control, optically isolated. Rating, 3 A max., 50 mA min., on 100-240 V a-c only. Contacts open on loss of power. Used with D.A.T. control to operate solenoid valve(s); can be used to operate auxiliary alarms, with C.A.T. or P.F.T. control.

Relays: Three, SPST. Rating, 10 W (4 W inductive), 0.5 A, 135 V a-c or 200 V d-c, max. (Product of voltage and current cannot exceed 10 W resistive.) Contacts open on loss of power. Used with P.F.T. control to drive pulse-input metering pump(s). Two relays used with dual-reagent C.A.T. control to switch control output signal between terminals, to appropriate reagent feeder. Relays not needed for control are available to operate auxiliary alarms, with "NO" or "NC" action.

Control Operation

C.A.T.: Provides isolated current outputs (see "Outputs", above) at *relay* terminals, when using dual reagent feeders; at *current-output* terminals, when using a single feeder, or split-range dual feeders.

D.A.T.: Provides triac output (see above), with impulse rate adjustable from 1 to 19.9 cycles/minute. "On" time—0 to 100%—is determined by control action.

P.F.T.: Provides relay contacts (see above) for either or both reagent feeders (metering pumps), with pulse frequency proportional to control output. Maximum frequency, adjustable 0.5 to 150 cycles/minute.

Controller Tuning Adjustments

Gain:	0.01 to 19.99 (proportional band: 5 to 10,000%)
Reset:	0 to 19.99 Repeats/min
Rate:	0 to 19.99 min
Lag:	(negative rate): 0 to 19.99 min
Adapt:	0-9

Temperature Compensation For pH: automatic, provided by compensator in pH electrode mounting assembly. Compensator signal also provides solution temperature; solution-temperature compensation may also be selected.

Power Requirements 100-132 or 200-264 V (switch-selected operation), 47-63 Hz, 15 VA.

Electrical Classification Suitable for non-hazardous and Class I, Division 2, Group B, C and D locations.

Case and Door Rugged gray Noryl case, NEMA 4X and 3R; ANSI C39.5 Enc. 4 and 5 (weatherproof, corrosion-resistant, dust-tight, outdoor). RF shielding in interior of case.

Case Dimensions Overall: 9⅛" (w) × 10¾" (h) × 7⅛" (d) (231 × 273 × 181 mm). Behind front surface of panel: 7⅛" (w) × 9¾" (h) × 5⅞" (d) (181 × 248 × 149 mm).

Weight 12 lb (5.5 kg).

Mounting Hardware furnished to panel-, wall- or pipe-mount the Analyzer/Controller.

HOW TO ORDER

Specify appropriate suffixes to complete the catalog number. The 7084 Analyzer/Controller is equipped to accept either a low-level preamplifier input or a 4-20 mA (transmitter) input, and provide any of the control outputs; Suffix A supplies a *separate* installation diagram appropriate to the application specified. (All applications are covered in the Operator's Manual.)

To order an Analyzer/Controller *without* a separate installation diagram, specify "7084-00-☐☐☐", using the appropriate Tagging Suffix B.

A B
7084 -☐☐-☐☐☐

Suffix A. Installation Diagram*

pH or Redox Input	Control Output		Installation Diagram	Suffix
No Separate Installation Diagram Supplied				00
Input from Preamplifier/ Electrode Mounting	C.A.T	Single Output*	C-ID-081221-1	01
		Dual Reagent Feeders	C-ID-081221-2	02
	D.A.T.	Single Reagent Feeder	C-ID-081221-3	03
		Dual Reagent Feeders	C-ID-081221-4	04
	P F T	Single Reagent Feeder	C-ID-081221-5	05
		Dual Reagent Feeders	C-ID-081221-6	06
Isolated 4-20 mA Input	C A T	Single Output*	C-ID-081221-11	11
		Dual Reagent Feeders	C-ID-081221-12	12
	D A T	Single Reagent Feeder	C-ID-081221-13	13
		Dual Reagent Feeders	C-ID-081221-14	14
	P F T	Single Reagent Feeder	C-ID-081221-15	15
		Dual Reagent Feeders	C-ID-081221-16	16

*Single output can be used for one reagent feeder, or two feeders with split ranges

Suffix B. Tagging (Specify Legend)

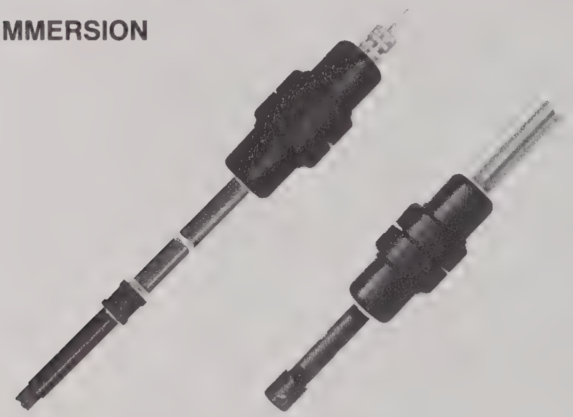
None	**000**
1 Linen Tag, 23 Characters Max. on Each of Six Lines	**206**
1 Aluminum Tag, 15 Characters Max. on One Line	**207**
1 Stainless Steel Tag, 25 Characters Max. on Each of Three Lines	**208**
Same as "208", but Permanently Mounted on Case	**209**

A 021855 Signal Horn (2700 Hz, 95 dBA; 1½" × 3½" dia. (38 × 89 mm dia.)), for operation from the Horn Output terminals, should be separately ordered.

pH/ORP Electrode Mountings

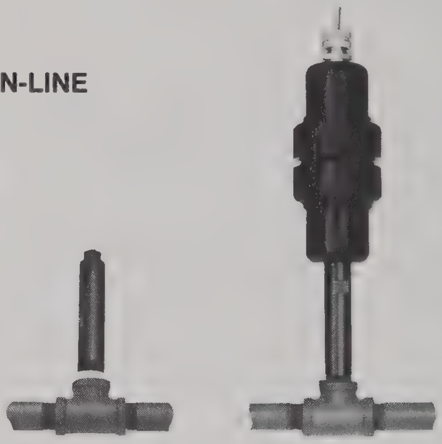
7777 with Meredian II Electrode

IMMERSION



- Single probe measuring & reference electrodes and temperature compensator
- Quick-disconnect electrode and preamplifier leads

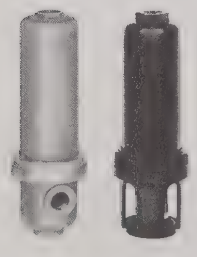
IN-LINE



- Flexible preamplifier location
- ¾″ MNPT connections — no O-rings

Data Sheet D2.1134-DS

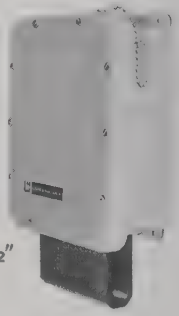
7773



- Multi-electrode mounting accepts widest variety of electrodes
- For immersion or flow-through installation with ¾″ FNPT connections
- Wide choice of wetted materials: Polypropylene, Ryton or stainless steel for high-purity water measurement
- Ultrasonic cleaner optional

Data Sheet D2.1119-DS

7779



- Self-cleaning in oily water
- Convenient ½″ NPT in-line mounting

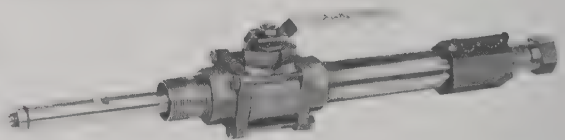
Data Sheet D2.1118-DS

7774

CPVC

- Electrode removable from pressurized system
- Single probe includes measuring, reference electrode, and temperature compensator

STAINLESS STEEL



- Non-fouling electrode tips for hi-density paper stock
- 316 stainless steel or CPVC construction

Data Sheet D2.1133-DS

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7082 Series Conductivity/Resistivity/ Concentration Analyzers

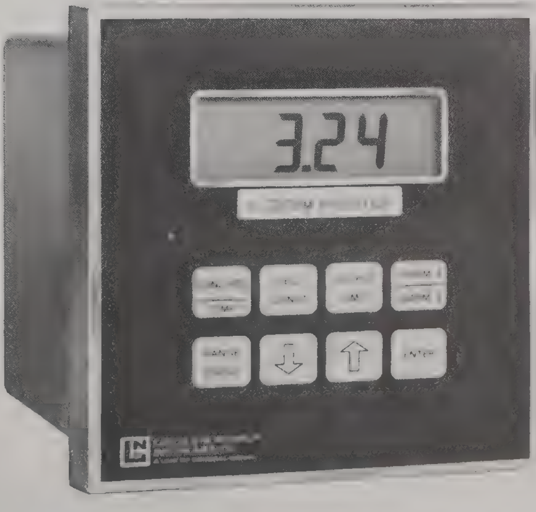
- **Accurate temperature compensated measurement over the ranges of 0.055 to 1,000,000 micromhos/cm and 0 to 18.2 Megohms-cm**
- **Microprocessor provides true high purity water temperature compensation for ion exchangers, semiconductor parts rinsing, boiler water analysis, pharmaceutical and reverse osmosis applications**
- **Accurate steam purity measurements are achieved with unique Cation/Ammonia and Morpholine temperature compensation**
- **Power plant model includes high temperature alarm capability to protect sensors from loss of coolant on steam samples**
- **Accurate concentration readout and "Full Spectrum Temperature Compensation" for percent sulfuric and hydrochloric acids, sodium hydroxide, sodium chloride, PPM TDS**
- **Linear concentration output signals**
- **Superior analog and digital design permits up to 1000′ separation of cell and analyzer without loss of accuracy**
- **Field selection of conductivity or resistivity readout can be made without changing cell**
- **Auto output scaling change**
- **Optional isolated outputs: 0-1 and 0-10V, 4-20 mA**
- **Two SPDT, Form C, 3-amp alarm relays**
- **Meets Class I, Division 2, Group A, B, C & D requirements when relays are not used**
- **On-line diagnostics continuously verify analyzer operation; off-line diagnostics enable verification of relays, outputs and external circuits**
- **Security lock can prevent change of instrument settings**
- **Compact, weatherproof, corrosion-resistant, RFI/EMI shielded, plastic case rated NEMA 4X**

The 7082 Analyzers, which are designed for use in Utilities, Semiconductor, Pulp & Paper, Chemical Processing, Biomedical, Biotech, and Pharmaceutical industries, offer custom features for operations such as ion exchangers, cooling towers reverse osmosis, boiler water analyses and rinse tanks.

Using industry-accepted algorithms, the 7082 Analyzer accurately compensates for conductivity changes with temperature over wide variations of water purity. Unique "cation/ammonia" temperature compensation increases the

ALARM
2
.055 µ℧/cm
CONDUCTIVITY
COND/RES
TEMP
CELL CONST
OUTPUT LIMIT
ALARM 1
ALARM 2
RANGE SELECT
ENTER
LEEDS & NORTHRUP INSTRUMENTS

Standard Range Analyzer for 0-10,000 micromhos/cm conductivity and resistivity ranges.



Wide Range Analyzer for 2,000 to 1,000,000 micromhos/cm conductivity and concentration ranges.

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Instrument & System Solutions!

accuracy of measurements in steam condensate analysis using Larson-Lane type cation exchange systems as well as "specific conductivity" measurements in ammonia-treated water.

The 7082 Analyzer can be calibrated directly from the front panel using known conductivity solutions and/or by storing a known cell calibration factor in memory. Such a combination permits on-line system calibration to accepted standards for ultimate system accuracy.

This advanced microprocessor-based analyzer is designed for use with L&N's proven conductivity cells and assures faster, more reliable, and much more accurate analysis and control than previously possible. A superior analog and digital design assures a reliable signal from the cell over the full display range and allows separation of the cell and Standard Range analyzer by as much as 1000′ without loss of accuracy. Analyzer readout may be changed in the field from conductivity to resistivity measurement on the Standard Range model.

Other innovations include:

User Friendly ¾″ High LCD indicates numerical values for conductivity/resistivity/concentration, process temperature and alarm set points with specific messages. A clearly dedicated keypad with tactile feedback eliminates the need for ambiguous number functions in normal operation. See Figure 1.

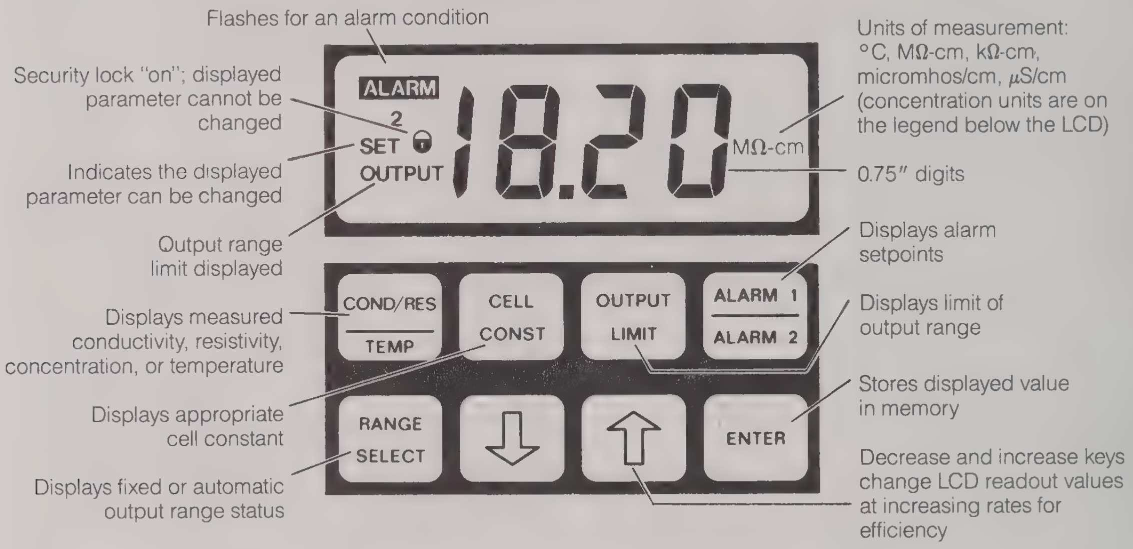
Flashes for an alarm condition
Security lock "on"; displayed parameter cannot be changed
Indicates the displayed parameter can be changed
Output range limit displayed
Displays measured conductivity, resistivity, concentration, or temperature
Displays appropriate cell constant
Displays fixed or automatic output range status
ALARM
2
SET
OUTPUT
18.20
MΩ-cm
COND/RES
TEMP
CELL CONST
OUTPUT LIMIT
ALARM 1
ALARM 2
RANGE SELECT
ENTER
Units of measurement: °C, MΩ-cm, kΩ-cm, micromhos/cm, μS/cm (concentration units are on the legend below the LCD)
0.75″ digits
Displays alarm setpoints
Displays limit of output range
Stores displayed value in memory
Decrease and increase keys change LCD readout values at increasing rates for efficiency

Fig. 1 Displays and functions on front panel of 7082 Analyzer

Output Range Selection is made from the front panel for any zero-based scaling from 0.1 to 10,000 micromhos/cm (microsiemens/cm) or from 4,000 ohms-cm to 20 Megohms-cm (with appropriate cells). Suppressed zero scaling is available on the Wide Range Analyzer for both conductivity and concentration ranges. This assures output compatibility in new or existing installations.

Automatic High Resolution Display, if selected by internal switch, shifts the decimal point to improve resolution when the readout value is below 10% of the display range with conductivity and resistivity measurements.

Auto Output Scaling Change, when selected, expands the scaling by a factor of 10 when the value falls below 10% of the high scaling range limit. The original output scaling is restored when the value exceeds 100% of the low scaling range. One SPDT relay may be dedicated to either indicate the output scaling status or to switch the output between two points of a multipoint recorder for range identification. See Figure 2.

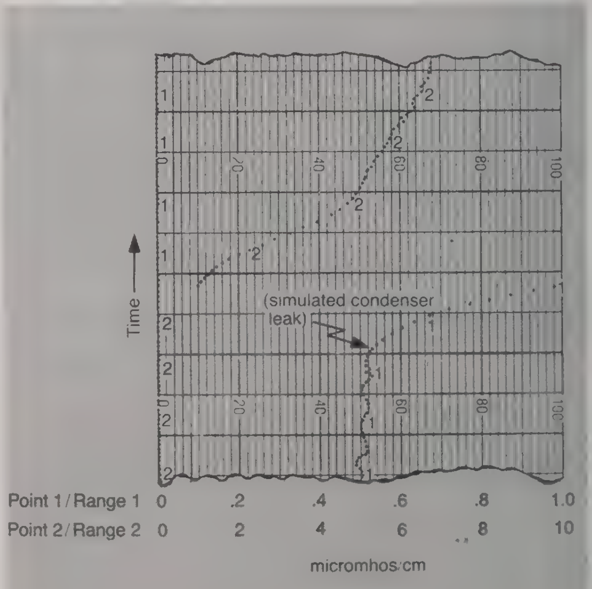

Fig. 2
Sample multipoint recorder chart illustrating Auto Output Scaling Change for steam condensate monitoring

Overlapping Multi-Range Capability can provide a selected range with either of 2 cell constants. Together, the Multi-Range and Auto-Range features permit operation over wide ranges with maximum accuracy and readability using a minimum variety of conductivity cells.

Concentration Measurements utilize extremely precise algorithms for conversion of conductivity and temperature inputs to concentration display and outputs. "Full Spectrum Temperature Compensation," unique for each reagent, automatically provides exact correction of temperature influences as they vary with both concentration and temperature.

Two Alarm/Control Relays are rated at 3 amps, SPDT, with selectable deadband. The two alarms can be dedicated for high-high, low-low or high-low alarm/control operation. Setpoints are digitally set from the front panel to any value in the selected range. Alternatively, one relay may be used with the Auto Output Scaling feature previously described.

Optional Outputs include isolated 0-1 and 0-10 Vdc and isolated 4-20 mA for direct connection to programmable logic controllers, data acquisition systems and recorders.

Rugged Plastic Case is corrosion-resistant, watertight and rated NEMA 4X, suitable for process washdown. EMI/RFI shielding prevents interference from electrical noise. Panel, pipe and wall mounting hardware are included for indoor or outdoor installation.

A Security Lock, set from the front panel, prevents unauthorized change of analyzer settings.

On-Line Diagnostics test operation of the following: battery, RAM or EPROM memory, A/D converter, cell and temperature signal range, temperature sensor and non-volatile RAM. Any failure would be identified by a designated number alternating with the normal readout. Long-life lithium battery back-up is provided to retain RAM memory values during process shutdown or power failure.

Set Up Diagnostics check keypad, display, relays and output signals for verification of external circuit operation.

High Purity Water

Special temperature compensation is required in the range of 0.055 to 5 micromhos/cm (microsiemens/cm)/0.2 to 18 Megohms-cm. Traditional compensation techniques used in most analog instruments require temperature compensator selection for a reference conductivity represented by a single curve in Fig. 3. This method lacks the capability to accurately reflect the changing temperature coefficient of water for variations in temperature and conductivity on either side of that reference value.

Advanced high-purity water temperature compensation determines the conductivity of an impurity at any concentration, of water at any temperature and the interaction between the two. It compensates these values to obtain the conductivity referenced to 25C. Because the temperature coefficients involved are both high and variable, a precise temperature measurement is required to achieve accurate compensation.

To accomplish this the L&N 7082 Analyzer first makes precise temperature measurements over a wide range, even with long sensor leads. Second, an accurate conductivity measurement is assured by use of the cell constant trim factor. Third, internal high resolution algorithms are used to make exact high-purity water calculations. This high level of performance in an inexpensive and highly reliable instrument is the result of over seventy years experience in making industrial conductivity measurements.

Specialized Temperature Compensation

For applications where acids or bases are the major contaminants rather than salts, unique algorithms may be switch selected to provide uncompromised temperature compensation accuracy.

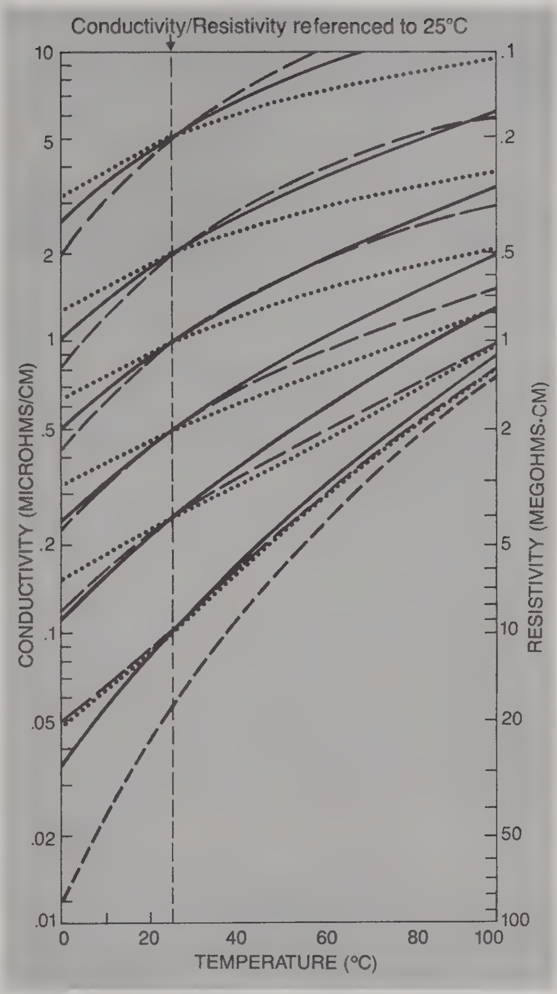

Fig. 3 Temperature effects on high-purity water. Curves represent different levels of water purity: solid curves for neutral salt impurities; dotted curves for acids and ammonia; dashed curves for morpholine. The bottom curve represents absolutely pure water.

Power Plant Cation/Ammonia conductivity temperature compensation provides highest accuracy for measurements of cation exchanger effluent and acidic "cation conductivity" samples with Larson Lane-type analyzers. This compensation matches both strong inorganic and weak organic acid temperature characteristics. Measurements of steam and condensate samples containing ammonia are also greatly improved using this algorithm.

Power Plant Morpholine conductivity temperature compensation was developed specifically for this emerging water chemistry. Morpholine has unique temperature characteristics as shown in Figure 3.

Semiconductor Etch Rinse resistivity temperature compensation provides the most accurate measurements of used rinse water containing traces of acidic etchants. Rinse quality control and water reclaim monitoring can be made with greater precision when this compensation is used.

SPECIFICATIONS

Display 3½ digit, 0.75″ LCD displays conductivity, resistivity, or concentration, temperature, alarm condition, alarm setpoints, calibration, output limit and diagnostics. The display may be configured to provide autoranging, moving the decimal point one place to increase resolution (low range listing below).

Standard Display Ranges, 7082-16†,-17,-18,-19

Conductivity (micromhos/cm or microsiemens/cm)		Resistivity (ohms-cm)		Cell Constant Required
High	Low	High	Low	(cm^{-1})
0-1.999	None	0-19.99M	0-1.999M	0.01
0-19.99	0-1.999	0-1.999M	0-199.9k	0.1
0-199.9	0-19.99	0-199.9k	0-19.99k	1.0
0-1999	0-199.9	0-19.99k	0-1.999k	10
0-10000	0-1999	0-4.00k	0-1.999k	50

†Does not include resistivity ranges.

Wide Display Ranges, 7082-13,-14,-15

Conductivity (micromhos/cm or microsiemens/cm)		Cell Constant Required
High	Low	(cm^{-1})
0-1999	0-199.9	0.1
0-19,990	0-1999	1
0-199,900	0-19,990	10
0-500,000	0-19,990	25
0-1,000,000	0-199,900	50
Concentration (by weight)		
0-18.00% Hydrochloric Acid		50#
0-19.99% Sulfuric Acid		50#
0-19.99% Sodium Hydroxide††		25 or 50#
0-19.99% Sodium Chloride		25 or 50#
0-1999 ppm TDS		0.1
0-19,990 ppm TDS		1
0-199,900 ppm TDS		10

†† The maximum sodium hydroxide concentration measurable by conductivity depends on temperature. Maximum allowed by the 7082 Analyzer is 10% at 0C, 13% at 25C and 20% at 75C, with linear interpolation between these points.

# Measurements in the lower ½ of the concentration ranges and below 50C may also use the next lower available cell constant.

Process Temperature Display: −9.9 to 100C, resolution 0.1C; 100C to 140C, resolution 1C

Output Range may be expanded to any zero-based range within the primary display range, such as 0 to 10.00 micromhos/cm with 0.1 cell constant. The Wide Range Analyzer also allows any suppressed zero scaling such as 1000 to 2500 micromhos/cm with 1 cell constant.

Auto Output Scaling Change when selected, expands the output by a factor of 10 when the measured value is less than 10% of the selected output range high limit. (Not applicable to concentration ranges.)

Output Range Status (an SPDT Relay provides automatic indication of range in use.)

Keypad Monoplanar front panel with 8 keys for pushbutton entry with tactile feedback.

Performance (under reference operating conditions)
Accuracy: conductivity/resistivity, ±0.5% of span;
Output, ±0.4% of span.
Drift: negligible.
Repeatability: ±0.1% of span, ±1 count.
Reference Operating Conditions: 25 ± 1C; 10-40% RH; 120 Vac Power; 25.0C measured process temperature.

System Performance
Temperature Measurement accuracy (without calibration, with up to 500′ of recommended leadwire): ±0.15 typical with 4973 cells.

Conductivity/Resistivity Accuracy: ±1.8% RSS, ±1.0% RMS, without calibration; may be improved using external standards.

Operating Influences (under normal operating conditions) Effect on accuracy (% of span): Temperature, 0.05%/C; RH, <1%; Line Voltage, <0.1%/volt; Power Loss, memory retention by lithium battery, with low battery warning.

Operating Conditions—Ambient temperature: Normal 0-60C, Extreme −10 to 60C; Storage −30 to 70C. Line Voltage: Normal 108-132 or 216-264V, Extreme 100-132 or 200-264 Vac, 47-63 Hz. RH: 90% max. non-condensing at 40C max.

Output Signals (Proportional to selected output range)
7082-15 &-19: none
7082-13 &-17: isolated 0-1V dc, 200 ohms min. load; 0-10V dc, 2000 ohms min. load
7082-14,-16 &-18: isolated 0-1 and 0-10 V dc and isolated 4-20 mA dc (600 ohms max. load)

Alarms/Controls Two SPDT, Form C relays max. rating:
Current: 3A ac or dc, resistive
Voltage: 250 Vac, 220 Vdc
Switching power: 125 VA ac, 60 Wdc

Field configurable for high-high, low-low or high-low alarm/control activation. Deadband: 0.005, 0.1, 1.0 or 10% of high range. Relay 2 may be field dedicated for either alarm/control or auto range functions. On Power Plant model, 7082-16, Relay 1 may be dedicated to high temperature or high conductivity alarm.

Temperature Compensation High resolution (0.05C, typical) temperature compensation by microprocessor calculation for high purity water and concentrations as well as routine water measurements. A choice of switch-selected temperature compensation algorithms are provided as follows.

7082-13,-14,-15: Salt or "Full Spectrum Compensation" for all Wide Range chemical concentrations.

7082-16—Power Plants: High Purity with salt, acid/ammonia or morpholine

7082-17,-18,-19: High Purity with salt or acid/ammonia.

Power Requirements 108-132 or 216-264 Vac, 47-63 Hz, 15 VA. Memory retained with lithium battery when power is off.

Electrical Classification Suitable for Div. 2 installation when relays are not used (or use 10V output to 7080 alarm module with Div. 2 relays—see Data Sheet C12.1390-DS).

Case Gray Noryl plastic, NEMA 4X Rainproof and Outdoor. Interior conductive coating to provide effective EMI/RFI shielding.

Case Dimensions 6⅛″×6⅛″×6″ (156×156×152 mm); mounting cutout 5.53″×5.53″ (141 ×141×141 mm).

Weight 4 lbs. (1.8 kg).

Mounting Panel, surface, and pipe-mounting hardware supplied. (Pipe mounting is not recommended if pipe is subject to severe vibration.)

HOW TO ORDER

7082 Analyzers can be ordered by 6-digit part number. If tagging is required, order by catalog number with the appropriate suffixes "A" and "B" as:

A B
7082-☐☐**-**☐☐☐ Analyzer

Suffix A:

Wide Ranges

—13	Voltage outputs only	**056419**
—14	Voltage and current outputs	**056420**
—15	No outputs	**056421**

Standard Ranges

—16	Power Plant functions, voltage and current outputs	**056422**
—17	Voltage outputs only	**056355**
—18	Voltage and current outputs	**056356**
—19	No outputs	**056362**

NOTE: Output options are not easily added in the field

Suffix B:

Optional Tagging (Specify legend)
—206 (1) linen tag, 23 characters max. on each of 6 lines
—207 (1) aluminum tag, 15 characters max. on 1 line
—208 (1) SS tag, 25 characters max. on each of 3 lines

Accessories

When ordering a conductivity cell, see specification Standard or Wide Display Ranges for cell constant and specify "333" for temperature compensator suffix.

Filler Plate Kit to mount a 7082 in an existing 7070, 7075, 7076, 7077 or 7078 panel cutout	**056349**
Junction Box (when cell leadwire is Suffix 7 or 20)	**316260**

Standard Range Extension Leadwires
(3-cond. & coax. required):

Up to 500 ft. use 18-gage, 3-cond. cable	**834059**
plus coaxial cable	**835024**
Up to 1000 ft. use 16-gage, 4-cond. cable*	**834055**
plus coaxial cable	**835024**

*3 conductors are used

Wide Range Extension Leadwire

Up to 500 ft. use 18-gage, 4-cond. cable	**834052**
Up to 1000 ft. use 16-gage, 4-cond. cable	**834055**

(Leadwire resistance compensation is provided in Wide Range Analyzers.)

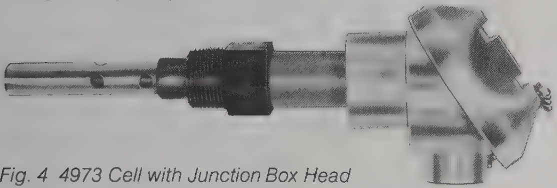

Fig. 4 4973 Cell with Junction Box Head

4973 Series Cells

4973 Series Cells are ruggedly constructed for reliable, continuous measurements of conductivity in industrial water processes at temperatures up to 140C at pressures up to 250 psig. They are constructed of polyethersulfone (PES) for high corrosion resistance, with electrodes of titanium (for 0.01 and 0.1 cell constants) or high-density carbon (for 1.0 and 10.0 cell constants).

For insertion applications, the ¾" NPT male thread permits permanent installation of the cell in a pipe or tank. For flow applications, the cell can be installed directly into a process stream, or used with a separately ordered 055919 Flow Chamber in a bypass stream.

Cell Constant 0.01, 0.1, 1.0 and 10 cm^{-1}.

Maximum Temperature Limit 140 C (284 F) at rated pressure.

Maximum Pressure Limit 250 psig (1724 kPa) at rated temperature.

Insertion ¾" NPT male thread for schedule 40 and 80 pipe.

Insertion Depth 3½ inches for 1, 10, and 0.01 constants from solution end of ¾" NPT male thread; 2½ inches for 0.1 constant.

Wetted Parts Cell body: PES (polyethersulfone). Electrodes: 0.01 and 0.1 constant, titanium; 1.0 and 10.0 constant, high-density graphite with Teflon guard.

Electrical Connections Integral PVC-covered non-shielded 18-gage 4-conductor cable, 7′ (2.1 m) or 20′ (6.1 m), as specified. If more than 20′ are required, specify the aluminum junction box head (Suffix C-1), or separate junction box and the required length of cables - see Accessories. Head has ½" FNPT conduit connection.

Weight 0.5 lb (0.2 kg).

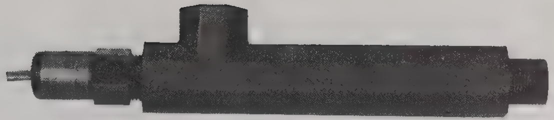

Fig. 5 055919 Flow Chamber (ordered separately) used with 4973 Cell for sample stream measurements

Specifications for 055919 Flow Chamber Max. Flow 5 gpm at 40 psig and atmospheric discharge; Max. Pressure 200 psig at 25C; Max. Temperature 140C at atmospheric pressure.

Dimensions 1½" (38 mm) octagon × 8¾" (222 mm) long. Sample inlet ¾" NPT male. Sample outlet ¾" NPT female. Cell port ¾" NPT female.

HOW TO ORDER

Specify Catalog Number and appropriate suffixes from the table below.

A B C
4973-□□□-333-□□

	Description	Suffix
Suffix A Cell Constant	0.01 0.1 1.0 10	001 01 1 10
Suffix C Terminal Connection	Integral Leadwire, 7′ Long Integral Leadwire, 20′ Long Junction Box Head Mounted on Cell	7 20 1

To achieve highest accuracy on 7082 Standard Ranges where normal operation is less than 10% of the high display range (for the selected cell constant), use extension leadwires listed under accessories for "Up to 500 ft," and specify Suffix C as either 1 or 7.

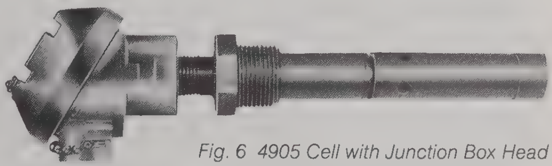

Fig. 6 4905 Cell with Junction Box Head

4905 Series Cells

Constructed of PES for high corrosion resistance, 4905 Series Cells can be supplied with either nickel or platinum electrodes, and will provide continuous, reliable measurements at temperatures up to 140C at pressures up to 250 psig.

For insertion applications, the 1" NPT male thread permits installation in a pipe or tank; for flow applications, the cell can be installed directly into a process stream, or used with a separately ordered 276127 Flow Chamber in a bypass stream. For immersion applications, ½" rigid or flexible plastic pipe can be threaded into the top of the cell: up to 6′ (1.8 m) for the 7′ cable, up to 19′ (5.8 m) for the 20′ cable.

Cell Constants 0.01, 0.1, 1.0, 10, 25, and 50 cm^{-1}.

Electrode Material Nickel or platinum, as specified.

Leadwire 4 leads Tefzel covered 18-gage cable 7′ or 20′.

Maximum Temperature 140C (284F) at rated pressure.

Maximum Pressure 250 psig (1724 kPa) at rated temperature.

Insertion 1" NPT male thread.

Insertion Depth 5½" to 7" (140 to 178 mm) depending on cell constant.

Overall Length Approximately 7 to 8½″ (178 to 216 mm) without head. Approximately 10 to 12¼″ (254 to 311 mm) with junction box head.

Wetted Materials Cell—polyethersulfone; Electrodes—Nickel or Platinum.

Weight Approximately 1 lb. (0.45 kg).

Fig. 7 276127 Flow Chamber (ordered separately) used with 4905 Cell for sample stream measurements

4909 Series Cell Assemblies

Specifications for 276127 Flow Chamber Max. Flow 2 gpm at 40 psig and atmospheric discharge; Max. Pressure 200 psig at 25C; Max. Temperature 140C at atmospheric pressure.

Dimensions 1½″ (38 mm) octagon × 8¾″ (222 mm) long. Sample inlet ¾″ NPT male. Sample outlet ¾″ NPT female. Cell port 1″ NPT female.

4909 Cell assemblies, which will provide reliable conductivity measurements at temperatures up to 140C, include a device that allows insertion or removal of the cell without interrupting the process. Two safety features, a restraining mechanism and an internal safety stop, provide protection to an operator for safe cell removal at pressures up to 50 psig with caution. The plastic removal device is equipped with a purge port to flush out any accumulated debris to aid in easy insertion or removal of the cell.

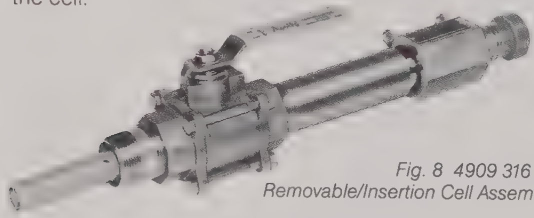

Fig. 8 4909 316 SS Removable/Insertion Cell Assembly

Specifications for 316 Stainless Steel

Cell Constants 0.01, 0.1, 1.0, 10, 25, and 50 cm^{-1}.

Electrode Material Nickel or platinum, as specified.

Leadwire 4 leads Tefzel covered 18-gage cable 7′ or 20′.

Pressure 200 psig (1379 kPa) maximum at 284 F (140 C). Maximum Pressure for removal or insertion is 50 psig.

Temperature 140 C (284 F) at 200 psig.

Process Connection 1¼″ NPT male.

Insertion Depth Varies between 3″ and 5¼″ (176 and 133 mm) depending on cell constant.

Overall Length (from process connection): 16.5″ (422 mm); 20.5″ (521 mm) with junction box head option.

Total Length Required for Cell Removal 44.5″ (1130 mm); 50.5″ (1283 mm) with junction box head option

Wetted Materials 316 SS ball valve, Viton & Teflon internal sealing materials. PES cell, nickel or platinum electrodes—as specified.

Weight 20 lbs. (9.0 kg).

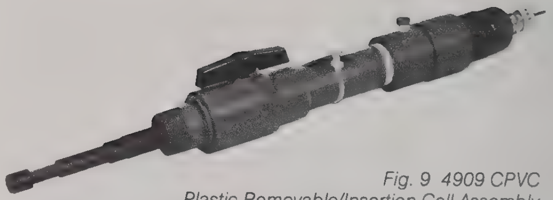

Fig. 9 4909 CPVC Plastic Removable/Insertion Cell Assembly

Specifications for CPVC Plastic

Cell Constants 0.01, 0.1, 1.0, 10, and 50 cm^{-1}.

Electrode Material Nickel or platinum, as specified.

Leadwire 4 leads Tefzel covered 18-gage cable 7′ or 20′.

Pressure & Temperature 125 psig (862 kPa) maximum @ 23 F (−5 C). 90 psig (621 kPa) maximum @ 122 F (50 C). 50 psig (345 kPa) maximum @ 176 F (80 C).

Process Connection 1½″ NPT male.

Purge Port Connection ¼″ NPT female. Purge fluid temperature and pressure not to exceed 4909 CPVC temperature and pressure specifications.

Insertion Depth Varies between 5½″ and 7″ (140 and 178 mm) depending on cell constant.

Overall Length (from process connection): 19.7″ (502 mm); 22.2″ (564 mm) with junction box head option.

Additional Allowance Required for Cell Removal 36″ (914 mm).

Wetted Materials CPVC ball valve, Viton, Teflon & EPDM internal sealing materials. PES cell, nickel or platinum electrodes—as specified.

Weight 3.5 lbs. (1.6 kg).

HOW TO ORDER

Specify Catalog Number and appropriate suffixes from the table below.

A B C D E**

4905
4909 -□□□-□□-333-□□-□□

	Description	Suffix
Suffix A Cell Constant required for 7082 display range	0.01 0.1 1 10 25 50	**001** **01** **1** **10** **25** **50**
Suffix B Electrode Material	Nickel Platinum	**33** **44**
Suffix D Terminal Connection	Internal Leadwire, 7′ Long Internal Leadwire, 20′ Long Cast-Aluminum Junction Head Mounted on Cell	**7** **20** **1**
Suffix E** Removal Device Material	316 Stainless Steel CPVC Plastic	**02** **03**

***omit Suffix E for 4905 Cell*

To achieve highest accuracy on 7082 Standard Ranges where normal operation is less than 10% of the high display range (for the selected cell constant), use extension leadwires listed under accessories for "Up to 500 ft." and specify Suffix D as either 1 or 7.

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Electrolytic Conductivity

C2.2215-DS

7082-26,-27 Two-Cell Ratio Conductivity/Resistivity Analyzers

Features

- 2-Cell input capability with calculation of Ratio, Difference, % Passage or % Rejection for reverse osmosis, demineralizer and other applications where comparison of measurements is needed.
- Output and alarms on input(s), temperature(s), and/or calculated parameter.
- Accurate temperature compensated measurements over the ranges of 0.055 to 19,990 microsiemens/cm (micromhos/cm), 0 to 18.2 megohm-cm and 0 to 10,000 ppm TDS (total dissolved solids) for each cell, with auto ranging display.
- Microprocessor provides true high purity water temperature compensation for all pure water applications.
- Accurate power plant steam purity measurements with unique Cation/Ammonia and Morpholine temperature compensation; advanced degassed cation conductivity features provide total anion readout as ppb chloride or sulfate ion.
- Adjustable TDS factor to match any process composition or conversion requirements for reverse osmosis or ion exchange.
- Resistivity "etch rinse" temperature compensation for higher accuracy in semiconductor acid rinse and reclaim monitoring.
- Display mode selectable as fixed or automatic-cycling through all parameters.
- 2-Cell input with difference calculation and alarm allows use of redundant cells for improved reliability.
- Use of "check" resistor on one input can give convenient instrument verification.
- Superior analog and digital design permits up to 1000′ separation of cells and analyzer without loss of accuracy.
- Auto output scaling change with SPDT relay indication.
- Optional isolated outputs: 0-1 V, 0-10 V and 4-20 mA.
- Two SPDT, Form C, 3-amp relays.
- Meets Class I, Division 2, Group A, B, C & D requirements when relays are not used.
- On-line diagnostics continuously verify analyzer operation and can optionally activate a relay; off-line diagnostics test relays, outputs and external circuits.
- Security lock allows display but prevents change of instrument settings.
- Weatherproof, corrosion-resistant, RFI/EMI shielded plastic case rated NEMA 4X.

1 2
1.23
RATIO
COND RES
TEMP
CELL CONST
OUTPUT LIMIT
ALARM 1
ALARM 2
RANGE SELECT
ENTER

Description

The 7082 Analyzers, which are designed for use in Utilities, Semiconductor, Pulp & Paper, Chemical Processing, Biomedical, Biotech, and Pharmaceutical industries, offer custom features for operations such as ion exchangers, cooling towers reverse osmosis, boiler water analyses and rinse tanks.

Using industry-accepted algorithms, the 7082 Analyzer accurately compensates for conductivity changes with temperature over wide variations of water purity. In the power industry, unique "cation/ammonia" temperature compensation increases the accuracy of measurements in steam condensate analysis using Larson-Lane type cation exchange systems as well as "specific conductivity" measurements in ammonia-treated water.

The 7082 is calibrated to particular L&N cells by storing the NIST-traceable cell calibration factors in memory. It can also be calibrated directly to known standard solutions. Such a combination permits on-line system calibration to any accepted standard for ultimate system accuracy.

Superior analog and digital design assures reliable signals from the cells over the full display range and allows separation of cells and analyzer by as much as 1000′ without loss of accuracy. Analyzer readout may be changed in the field from conductivity to resistivity to TDS measurement.

A user-friendly ¾″ high LCD indicates numerical values for conductivity/resistivity/TDS, calculated value, process temperature and alarm set points with specific messages. A clearly dedicated keypad with tactile feedback eliminates the need for ambiguous number functions in normal operation.

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Instrument & System Solutions!

Description continued

An optional display scan mode sequentially displays measurement 1, measurement 2, temperature 1, temperature 2, calculated value, with a 3 second dwell time on each value. (Alarms and output update every second.)

Output Range Selection is made from the front panel for any scaling from 0 to 19,990 microsiemens/cm, 0 to 20 Megohms-cm, 0 to 10,000 ppm TDS, or −9.9 to 140C (with appropriate cells). Suppressed zero scaling is available.

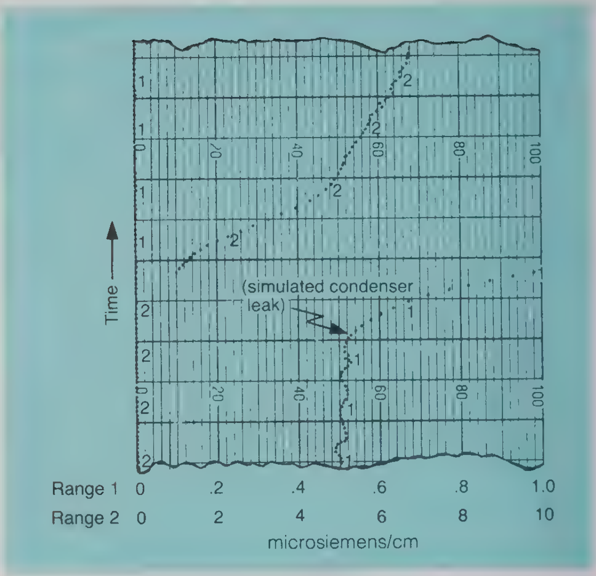
Automatic High Resolution Display, on most ranges is selected by internal switch and shifts the decimal point to improve resolution when the readout value is below 10% or below 1% of the highest display range.

Auto Output Scaling Change, when selected, expands the scaling by a factor of 10 when the value falls below 10% of the high scaling range limit. The original output scaling is restored when the value exceeds 100% of the low scaling range. One SPDT relay may be dedicated to either indicate the output scaling status or to switch the output between two points of a multipoint recorder for range identification. See Figure

Two Alarm/Control Relays are rated at 3 amps, SPDT, with selectable deadband. The two alarms can be dedicated for high-high, low-low or high-low alarm/control of either or both measurements, temperatures, or calculated value. A process upset delay timer can prevent false alarms by an adjustable delay period. Setpoints are digitally set from the front panel to any value in the selected range. Alternatively, one relay may be used with the Auto Output Scaling feature. If selected, the other relay may be activated by on-line diagnostic failures.

Optional Outputs, representing a measured value, temperature or a calculated value include 0-1 V, 0-10 V dc and 4-20 mA, all isolated, for direct connection to programmable logic controllers, data acquisition systems and recorders.

Rugged Plastic Case is corrosion-resistant, watertight and rated NEMA 4X, suitable for process washdown. EMI/RFI shielding prevents interference from electrical noise. Panel, pipe and wall mounting hardware are included for indoor or outdoor installation.



Sample multipoint recorder chart illustrating Auto Output Scaling Change for steam condensate monitoring.

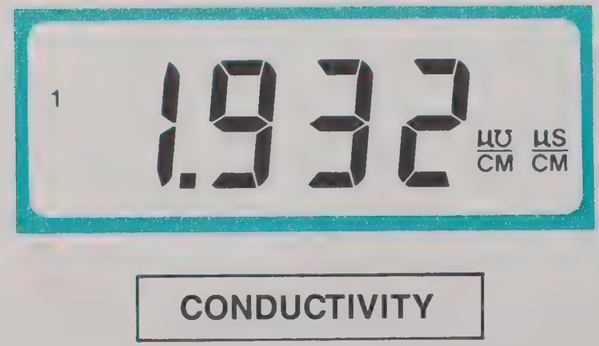
A Security Lock, set from the front panel, prevents unauthorized change but allows viewing of analyzer settings.

On-Line Diagnostics test operation of the following: battery, RAM or EPROM memory, A/D converter, cell and temperature signal ranges, temperature sensors and non-volatile RAM. Failure would be identified by a designated number alternating with the normal readout. Optionally, an alarm relay may be activated by an on-line failure. Long-life lithium battery backup is provided to retain RAM memory values during process shut-down or power failure.

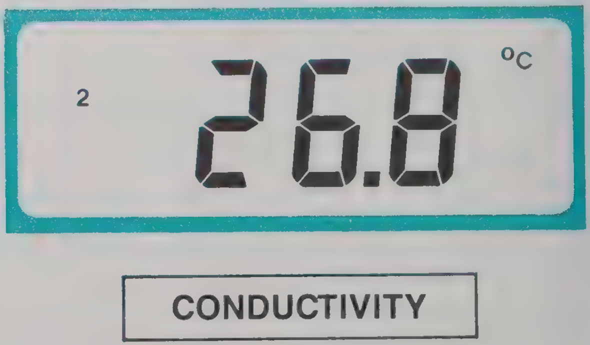
Set Up Diagnostics check keypad, display, relays and output signals for verification of external circuit operation.

Typical Display Messages

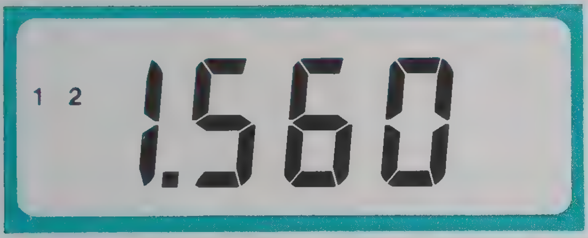
The legend below the display is selected by application from insert cards labelled: CONDUCTIVITY, RESISTIVITY, ppm TDS, ppb TDS, % PASSAGE, % REJECTION, DIFFERENCE, ppm CHLORIDE, ppb CHLORIDE, ppm SULFATE, ppb SULFATE. A custom label may also be inserted.



Cell 1 Conductivity Value.

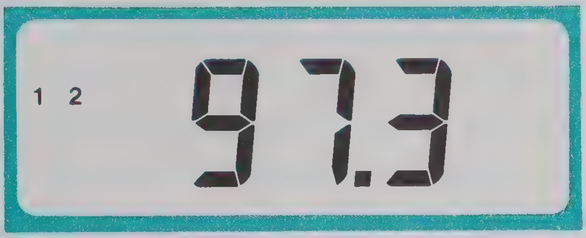


Cell 2 Temperature Value.



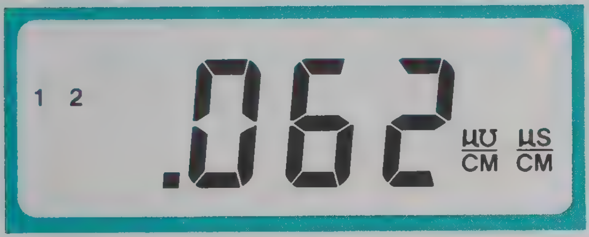
RATIO

Cell 1/Cell 2 Value.



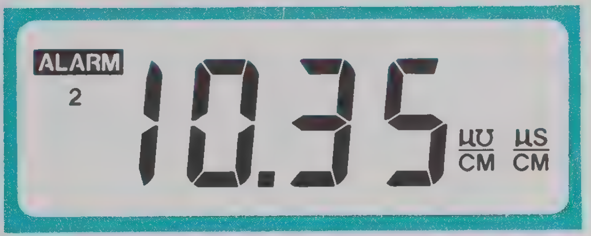
% REJECTION

Computed Rejection Value.


1 2
.062
μ℧/CM
μS/CM

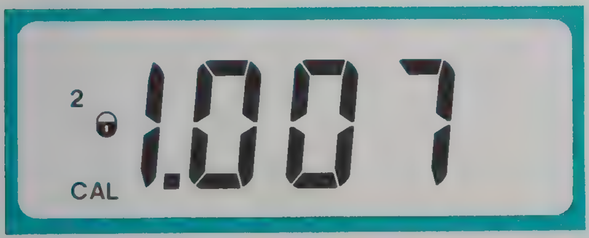
DIFFERENCE

Cell 1—Cell 2 Value.


ALARM
2
10.35
μ℧/CM
μS/CM

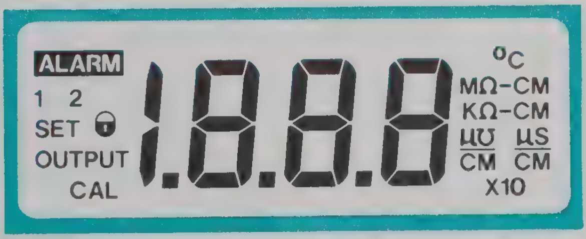
CONDUCTIVITY

Alarm 2 Condition—"Alarm 2" Flashes



CONDUCTIVITY

Cell 2 Calibration Factor Mode with security lock active.


ALARM
1 2
SET
OUTPUT
CAL
1.8.8.8
°C
MΩ-CM
KΩ-CM
μ℧/CM
μS/CM
X10

CONDUCTIVITY

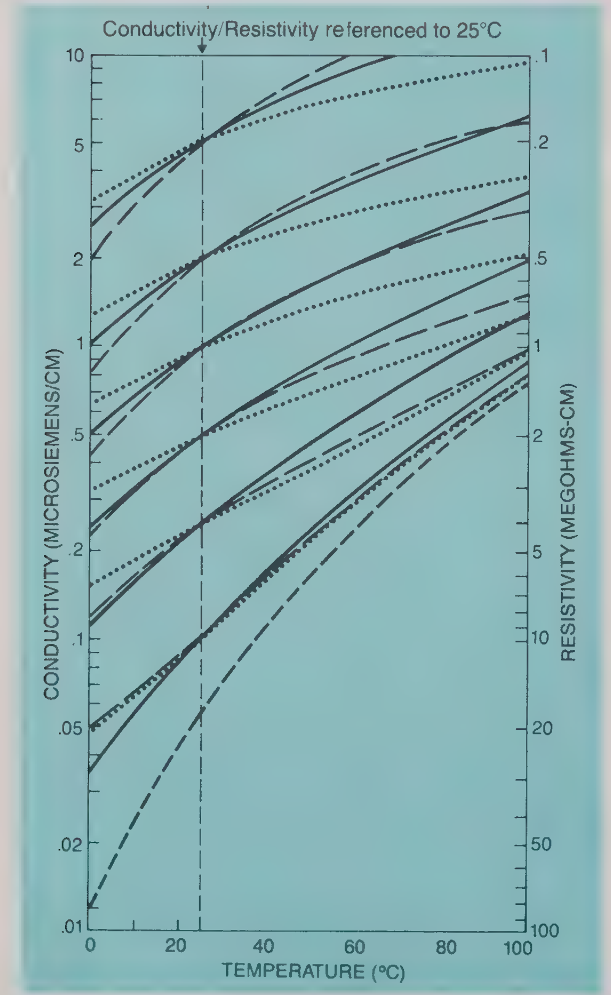
Diagnostics Mode—all messages displayed.

High Purity Water

Special temperature compensation is required in the range of 0.055 to 5 microsiemens/cm (0.2 to 18.2 Megohms-cm.) Traditional compensation techniques used in most analog instruments require temperature compensator selection for a reference conductivity represented by a single curve or offer an adjustment which also represents only a single curve for a given setting as in the Figure. These methods lack the capability to accurately reflect the changing temperature coefficient of water for variations in temperature and conductivity on either side of that reference value.

Advanced high-purity temperature compensation determines the total conductivity at any concentration, the conductivity of water at any temperature and the interaction between the two. It compensates these values to obtain the conductivity referenced to 25C. Because the temperature coefficients involved are both high and variable, a precise temperature measurement is required to achieve accurate compensation.

To accomplish this the L&N 7082 Analyzer first makes precise temperature measurements over a wide range, even with long sensor leads. Second, an accurate conductivity measurement is assured by use of the cell calibration factor.



Temperature effects on high-purity water. Curves represent different levels of water purity: solid curves for neutral salt impurities; dotted curves for acids and ammonia; dashed curves for morpholine. The bottom curve represents absolutely pure water.

Third, internal high resolution algorithms are used to make exact high-purity water calculations. This high level of performance in an inexpensive and highly reliable instrument is the result of Leeds & Northrup's seventy years experience in making industrial conductivity measurements.

Specialized Temperature Compensation

For applications where acids or bases are the major contaminants rather than salts, unique algorithms may be switch selected to provide uncompromised temperature compensation accuracy. Uncompensated conductivity or resistivity can also be displayed for verifying compensation performance.

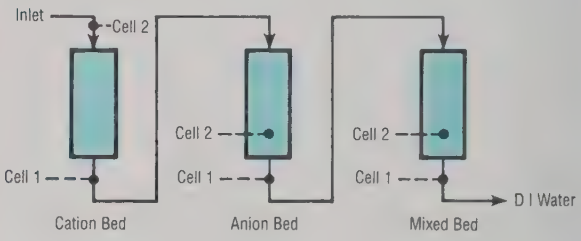
Power Plant Cation/Ammonia conductivity temperature compensation provides highest accuracy for measurements of cation exchanger effluent and acidic "cation conductivity" samples with Larson Lane-type analyzers. This compensation matches both strong inorganic and weak organic acid temperature characteristics. Measurements of steam and condensate samples containing ammonia are also greatly improved using this algorithm.

Power Plant Morpholine conductivity temperature compensation was developed specifically for this emerging water chemistry. Morpholine has unique temperature characteristics as shown in the Figure.

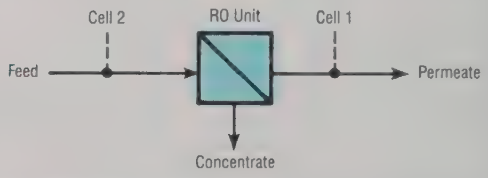
Semiconductor Etch Rinse resistivity temperature compensation provides the most accurate measurements of used rinsewater containing traces of acidic etchants. Rinse quality control and water reclaim monitoring can be made with greater precision when this compensation is used.

Two-Cell Applications

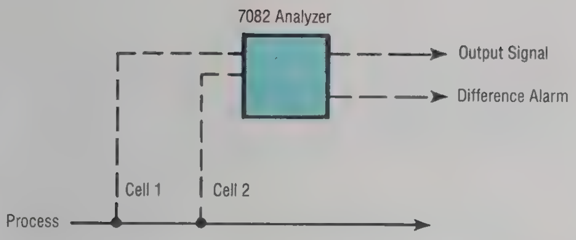
For more detailed descriptions refer to specific Application Data Sheets on these processes.



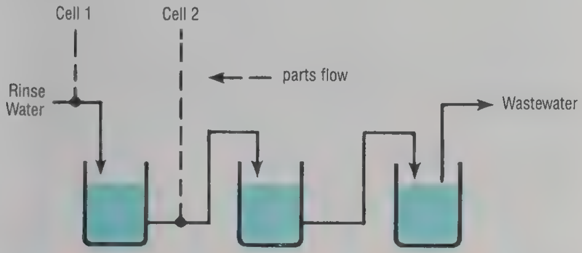
Ion exchange operations can achieve especially precise control using the conductivity ratio of two points with each bed. Ratio measurement accounts for feedwater variations when the upstream point is measured at the cation bed inlet. With the upstream point *in* the bed as shown for following stages, it can identify exhaustion before breakthrough. For more information, see Application Data Sheet C2.2216-ADS.



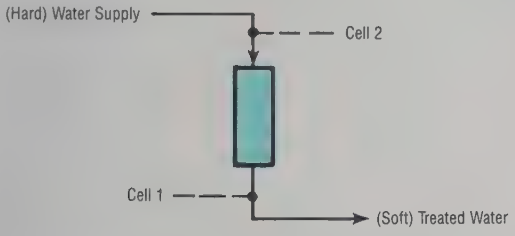
Reverse osmosis efficiency is monitored by comparing inlet and outlet conductivity (or TDS). Automatic calculations of Percent Rejection or Percent Passage are provided. Temperature readout assists with normalized performance comparisons. For more information, see Application Data Sheet C2.2217-ADS.



Conductivity/Resistivity/TDS difference using redundant cells on critical processes can provide a valuable diagnostic capability. If the difference in measurements exceeds the alarm point, an operator is summoned for corrective action. Monitoring may be switched to the alternate cell during maintenance. A different kind of diagnostic can be provided by a precision check resistor in place of one cell to give continuous analyzer checking at one value. For more information, see Application Data Sheet C2.2218-ADS.



Parts rinsing is usually controlled by conductivity to obtain adequate rinsing without wasting excess water, whether a single stage or a counter-current series of tanks. The 2-Cell ratio approach can determine whether inadequate rinsing is due to low flowrate or due to poor supply water quality. For more information, see Application Data Sheet C2.2219-ADS



Softener monitoring by conductivity ratio gives a continuous indication of performance, Sodium is typically more conductive than the hardness minerals it displaces, yielding a higher conductivity at the outlet. A ratio approaching 1 indicates that hardness ions are breaking through and that regeneration is needed. For more information, see Application Data Sheet C2.2220-ADS.

Specifications, Analyzer

Display 3½ digit, 0.75″ LCD displays conductivity, resistivity, or TDS, calculated parameter, temperatures, alarm conditions, alarm setpoints, calibration, output limits and diagnostics. The display may be configured to provide autoranging, moving the decimal point to increase resolution in low ranges listed below. Display update time is 1 second. Scan mode displays each variable for 3 seconds. (Alarms and output are updated every second in all display modes.)

Display Ranges, 7082 -26, -27

Cell 1 and Cell 2 may have different constants.

Conductivity (microsiemens/cm)		TDS*		Resistivity (ohms-cm)		Cell Constant Required
High	Low	High	Low	High	Low	(cm^{-1})
0-1.999	None	0-1999 ppb	0-199.9 ppb	0-19.99M	0-1.999M	0.01
0-19.99	0-1.999	0-19,990 ppb	0-1999 ppb	0-1.999M	0-199.9k	0.1**
0-199.9	0-19.99	0-199.9 ppm	0-19.99 ppm	0-199.9k	0-19.99k	1.0
0-1999	0-199.9	0-1999 ppm	0-199.9 ppm	—	—	10
0-19,990	0-1999	0-10,000 ppm	0-1999 ppm	—	—	25 or 50

*For power plant degassed cation conductivity measurements, readout may be ppb chloride or sulfate.

**Recommended constant for most power plant applications.

Computed Parameters	
Ratio:	0.001-19,990
Difference:	0 to +/−19,990
Passage or Rejection:	0-100.0%

Process Temperature Display: −9.9 to 100C, resolution 0.1C; 100C to 140C, resolution 1C

Output Range may be scaled to any range within the display ranges, such as 0 to 10.00 microsiemens/cm with 0.1 cell constant. The output may also represent temperature or a computed parameter.

Auto Output Scaling Change when selected, expands the output by a factor of 10 when the measured value is less than 10% of the selected output range high limit.

Output Range Status (an SPDT Relay can provide automatic indication of range in use.)

Keypad Monoplanar front panel with 8 keys for pushbutton entry with tactile feedback.

Performance (under reference operating conditions)
Accuracy: conductivity/resistivity, ±0.5% of span;
Output, ±0.4% of span.
Drift: negligible.
Repeatability: ±0.1% of span, ±1 count.
Reference Operating Conditions: 25±1C; 10-40% RH;
120 Vac Power; 25.0C measured process temperature.

System Performance
Temperature Measurement accuracy (without calibration, with up to 500′ of recommended leadwire): ±0.15C typical with 4973 cells.

Conductivity/Resistivity Accuracy: ±1.8% RSS, ±1.0% RMS, without calibration; may be improved using external standards.

Operating Influences (under normal operating conditions)
Effect on accuracy (% of span): Temperature, 0.05%/C; RH, <1%; Line Voltage, <0.1%/volt; Power Loss, memory retention by lithium battery, with low battery warning.

Operating Conditions—Ambient temperature: Normal 0-60C, Extreme −10 to 60C; Storage −30 to 70C. Line Voltage: Normal 108-132 or 216-264V, Extreme 100-132 or 200-264 Vac, 47-63 Hz. RH: 90% max. non-condensing at 40C max.

Output Signals (Proportional to selected output range)
7082-27 none
7082-26; isolated 0-1V dc, 200 ohms min. load; 0-10V dc, 2000 ohms min. load and isolated 4-20 mA dc (600 ohms max. load)

Alarms/Controls Two SPDT, Form C relays, max. rating:
Current: 3A ac or dc, resistive
Voltage: 250 Vac, 220 Vdc
Switching power: 125 VA ac, 60 Wdc

Specifications, Analyzer continued

Field configurable for high-high, low-low or high-low alarm/control of conductivity/resistivity, temperature or computed parameter. Deadband: 0.005, 0.1, 1.0 or 10% of high range. Relay 2 may be field dedicated for either alarm/control or auto range functions. Relay 1 may be activated by on-line diagnostic failure.

Temperature Compensation High resolution (0.05C, typical) temperature compensation by microprocessor calculation for high purity water as well as routine water measurements. The choice of switch-selected temperature compensation algorithms includes high purity with salt, acid/ammonia or morpholine.

Power Requirements 108-132 or 216-264 Vac, 47-63 Hz, 15 VA. Memory retained with lithium battery when power is off.

Electrical Classification Suitable for Div. 2 installation when relays are not used (or use 10V output to 7080 alarm module with Div. 2 relays—see Data Sheet C12.1390-DS).

Case Gray Noryl plastic, NEMA 4X Rainproof and Outdoor. Interior conductive coating to provide effective EMI/RFI shielding.

Case Dimensions 6⅛″ × 6⅛″ × 6″ (156 × 156 × 152 mm); mounting cutout 5.53″ × 5.53″ (141 × 141 mm).

Weight 4 lbs (1.8 kg).

Mounting Panel, surface, and pipe-mounting hardware supplied. (Pipe mounting is not recommended if pipe is subject to severe vibration.)

How to Order Analyzer

7082 Analyzers can be ordered by 6-digit part number. If tagging is required, order by catalog number with the appropriate suffixes "A" and "B" as:

A B
7082-☐-☐ Analyzer

Suffix A:

-26	Voltage and current outputs	**056429**
-27	No outputs	**056430**

NOTE: Outputs are not easily added in the field.

Suffix B:

Optional Tagging (Specify legend)

- **—206** (1) linen tag, 23 characters max. on each of 6 lines
- **—207** (1) aluminum tag, 15 characters max. on 1 line
- **—208** (1) SS tag, 25 characters max. on each of 3 lines

Accessories

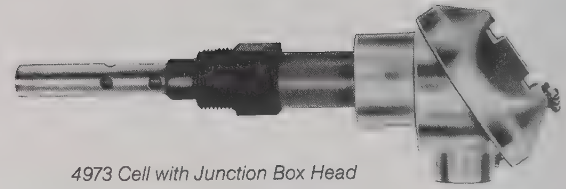
When ordering conductivity cells, see 7082 Ranges for cell constant and specify **"333"** for temperature compensator suffix.

Filler Plate Kit to mount a 7082 in an existing 7070, 7075, 7076, 7077 or 7078 panel cutout	**056349**
Junction Box (when cell leadwire is Suffix 7 or 20)	**316260**

Extension Leadwires
(3-cond. & coax. required)

Up to 500 ft. use 18-gage, 3-cond. cable	**834059**
plus coaxial cable	**835024**
Up to 1000 ft. use 16-gage, 4-cond. cable*	**834055**
plus coaxial cable	**835024**

*3 conductors are used



4973 Cell with Junction Box Head

4973-Series Cells

4973 Series Cells are ruggedly constructed for reliable continuous measurements of conductivity in industrial water processes at temperatures up to 140C at pressures up to 250 psig. They are constructed of polyethersulfone (PES) for high corrosion resistance, with electrodes of titanium (for 0.01 and 0.1 cell constants) or high-density graphite (for 1.0 and 10.0 cell constants).

For insertion applications, the ¾″ NPT male thread permits permanent installation of the cell in a pipe or tank. For flow applications, the cell can be installed directly into a process stream, or used with a separately ordered 055919 Flow Chamber in a bypass stream.

Cell Constant 0.01, 0.1, 1.0 and 10 cm^{-1}.

Maximum Temperature Limit 140 C (284 F) at rated pressure.

Maximum Pressure Limit 250 psig (1724 kPa) at rated temperature.

Insertion ¾″ NPT male thread for schedule 40 and 80 pipe.

Insertion Depth 3½ inches for 1, 10, and 0.01 constants from solution end of ¾″ NPT male thread; 2½ inches for 0.1 constant.

Wetted Parts Cell body: PES (polyethersulfone). Electrodes: 0.01 and 0.1 constant, titanium; 1.0 and 10.0 constant, high-density graphite with Teflon guard.

Electrical Connections Integral PVC-covered non-shielded 18-gage 4-conductor cable, 7′ (2.1 m) or 20′ (6.1 m), as specified. If more than 20′ are required, specify the aluminum junction box head (Suffix C-1), or separate junction box and the required length of cables - see Accessories. Head has ½″ FNPT conduit connection.

Weight 0.5 lb (0.2 kg).

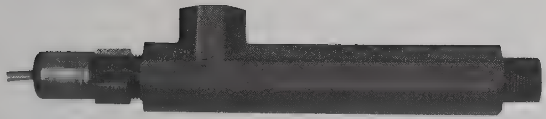
How To Order 4973 Cells

Specify Catalog Number and appropriate suffixes from the table below.

A B C
4973-☐-333-☐

	Description	Suffix
Suffix A Cell Constant	0.01	**001**
	0 1	**01**
	1.0	**1**
	10	**10**
Suffix C Connection	Integral Leadwire, 7′ Long	**7**
	Integral Leadwire, 20′ Long	**20**
	Junction Box Head Mounted on Cell	**1**

To achieve highest accuracy on 7082 Standard Ranges where normal operation is less than 10% of the high display range (for the selected cell constant), use extension leadwires listed under accessories for "Up to 500 ft," and specify Suffix C as either 1 or 7.



055919 Flow Chamber (ordered separately) used with 4973 Cell for sample stream measurements

055919 PES Flow Chamber

Maximum Flow 5 gpm at 40 psig and atmospheric discharge.

Maximum Pressure 200psig at 25C.

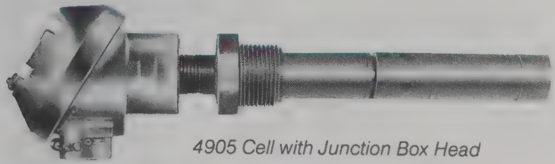
Maximum Temperature 140C at atmospheric pressure.

Dimensions 1½″ (38mm) octagon X 8¾″ (222 mm) long.

Sample Inlet ¾″ NPT male.

Sample Outlet ¾″ NPT female.

Cell Port ¾″NPT female.



4905 Cell with Junction Box Head

4905-Series Cells

Constructed of PES for high corrosion resistance, 4905 Series Cells can be supplied with either nickel or platinum electrodes, and will provide continuous, reliable measurements at temperatures up to 140C at pressures up to 250 psig.

For insertion applications, the 1″ NPT male thread permits installation in a pipe or tank; for flow applications, the cell can be installed directly into a process stream, or used with a separately ordered 276127 Flow Chamber in a bypass stream. For immersion applications, ½″ NPT pipe can be threaded into the top of the cell.

Cell Constants 0.01, 0.1, 1, 10, 25 and 50 cm^{-1}.

Electrode Material Nickel or platinum, as specified.

Leadwire 4 leads Tefzel covered 18-gage cable 7′ or 20′.

Maximum Temperature 140C (284F) at rated pressure.

Maximum Pressure 250 psig (1724 kPa) at rated temperature.

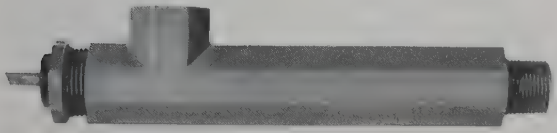
Insertion 1″ NPT male thread.

Insertion Depth 5½″ to 7″ (140 to 178 mm) depending on cell constant.

Overall Length Approximately 7 to 8½″ (178 to 216 mm) without head. Approximately 10 to 12¼″ (254 to 311 mm) with junction box head.

Wetted Materials Cell—polyethersulfone; Electrodes—Nickel or Platinum.

Weight Approximately 1 lb. (0.45 kg).



276127 Flow Chamber (ordered separately) used with 4905 Cell for sample stream measurements.

276127 PES Flow Chamber

Maximum Flow 2 gpm at 40 psig and atmospheric discharge.

Maximum Pressure 200 psig at 25C.

Maximum Temperature 140C at atmospheric pressure.

Dimensions 1½″ (38mm) octagon X 8¾″ (222mm) long.

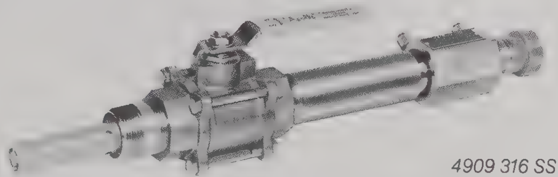
Sample Inlet ¾″ NPT male.

Sample Outlet ¾″NPT female.

Cell Port 1″ NPT female.

4909-Series Cell Assemblies

4909 Cell Assemblies, available in 316 Stainless Steel or CPVC Plastic, allow insertion or removal of the cell without interrupting the process. Two safety features, a restraining mechanism and an internal safety stop, provide protection to an operator for safe cell removal at pressures up to 50 psig with caution. The plastic removal device is equipped with a purge port to flush out any accumulated debris to aid in easy insertion or removal of the cell.



4909 316 SS Removable/Insertion Cell Assembly

4909 Stainless Steel Assembly

Cell Constants 0.01, 0.1, 1.0, 10, 25, and 50 cm^{-1}.

Electrode Material Nickel or platinum, as specified.

Leadwire 4 leads Tefzel covered 18-gage cable 7′ or 20′.

Pressure 200 psig (1379 kPa) maximum at 284 F (140 C). Maximum Pressure for removal or insertion is 50 psig.

Temperature 140 C (284 F) at 200 psig.

Process Connection 1¼″ NPT male.

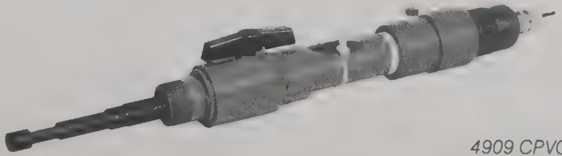
Insertion Depth Varies between 3″ and 5¼″ (176 and 133 mm) depending on cell constant.

Overall Length (from process connection): 16.5″ (422 mm); 20.5″ (521 mm) with junction box head option.

Total Length Required for Cell Removal 44.5″ (1130 mm); 50.5″ (1283 mm) with junction box head option.

Wetted Materials 316 SS ball valve, Viton & Teflon internal sealing materials. PES cell, nickel or platinum electrodes—as specified.

Weight 10 lbs. (4.5 kg).



4909 CPVC Plastic Removable/Insertion Cell Assembly

4909 CPVC Plastic Assembly

Cell Constants 0.01, 0.1, 1.0, 10, 25 and 50 cm^{-1}.

Electrode Material Nickel or platinum, as specified.

Leadwire 4 leads Tefzel covered 18-gage cable 7′ or 20′.

4909 CPVC Plastic Assembly continued

Pressure & Temperature 125 psig (862 kPa) maximum @ 23 F (−.5 C). 90 psig (621 kPa) maximum @ 122 F (50 C). 50 psig (345 kPa) maximum @ 176 F (80 C).

Process Connection 1½″ NPT male.

Purge Port Connection ¼″ NPT female. Purge fluid temperature and pressure not to exceed 4909 CPVC temperature and pressure specifications.

Insertion Depth Varies between 5½″ and 7″ (140 and 178 mm) depending on cell constant.

Overall Length (from process connection): 19.7″ (502 mm); 22.2″.(564 mm) with junction box head option.

Additional Allowance Required for Cell Removal 36″ (914 mm).

Wetted Materials CPVC ball valve, Viton, Teflon & EPDM internal sealing materials. PES cell, nickel or platinum electrodes—as specified.

Weight 3.5 lbs. (1.6 kg).

How To Order 4905 or 4909 Cells

Specify Catalog Number and appropriate suffixes from the table below.

A B C D E**
4905 - ☐-☐-333-☐-☐
4909

	Description	Suffix
Suffix A Cell Constant required for 7082 display range	0.01 0.1 1 10 25 50	001 01 1 10 25 50
Suffix B Electrode Material	Nickel Platinum	33 44
Suffix D Connection	Leadwire, 7′ Long Leadwire, 20′ Long Cast-Aluminum Junction Head Mounted on Cell	7 20 1
Suffix E** Removal Device Material	316 Stainless Steel CPVC Plastic	02 03

***omit Suffix E for 4905 Cell*

To achieve highest accuracy on 7082 Standard Ranges where normal operation is less than 10% of the high display range (for the selected cell constant), use extension leadwires listed under accessories for "Up to 500 ft." and specify Suffix D as either 1 or 7.

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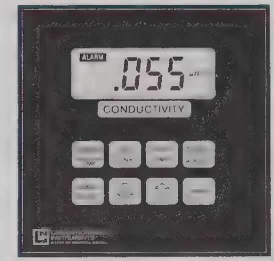
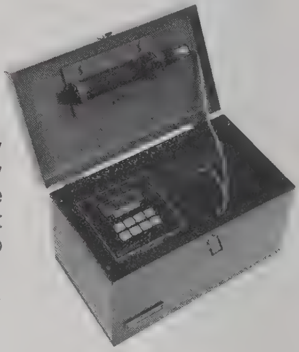
Other members of the 7082 Analyzer Family



7082 Single-point Conductivity/Resistivity Analyzers provide similar features to the 2-cell analyzer at lower cost.
See Data Sheet C2.2211-DS.



7082 Portable High Purity Conductivity and Resistivity Analyzers provide on-line checking of samples without the problems of grab sample contamination.
See Data Sheet C2.2214-DS.

7082 Wide Range Conductivity Analyzers provide direct reading concentration ranges of percent sodium hydroxide, sulfuric acid, hydrochloric acid and sodium chloride as well as conductivity to 1 siemens/cm for D.I. and softener regenerant dilution control.
See Data Sheet C2.2211-DS.

7082 pH Analyzers provide accurate measurement in both high purity and wastewaters.
See Data Sheet C2.1211-DS.

7082 Portable pH Analyzers provide on-line checking of samples without the problems of grab sample contamination.
See Data Sheet C2.2214-DS.

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7082-Series Portable High-Purity pH, Conductivity and Resistivity Analyzers

- **Line-Operated High Purity portable standards.**
- **Eliminate grab sample contamination.**
- **Rugged, extruded aluminum case.**
- **Most advanced High-Purity conductivity/resistivity temperature compensation, for Salt, "Cation/Ammonia," Morpholine, and Etch Rinse applications.**
- **Adjustable pH Solution Temperature Compensation in addition to conventional Electrode Temperature Compensation.**
- **Traceable to NBS/ASTM standards.**
- **0-1 V, 0-10 V and 4-20 mA isolated outputs for long-term trending.**

The Portable 7082 Analyzers provide advanced features specifically designed for High-Purity water measurements in the power, microelectronics, chemical, pulp & paper and pharmaceutical industries. Utilizing the industry-proven 7082 on-line analyzers, these portable units are housed in rugged aluminum cases for convenient on-site sampling. As portable standards, these analyzers can be used to verify or calibrate on-line analyzers without subjecting grab samples to atmospheric contamination by carbon dioxide or questionable handling, thus assuring sample integrity.

The convenient packaging of a truly industrial analyzer and fast responding sensor, together with the speed of pushbutton calibration and direct readout saves valuable time in both routine checks and emergency measurement situations. The portable unit can also serve as a back up analyzer should an on-line instrument require servicing.

Conductivity and Resistivity Most portable instruments provide only the conventional 2 percent per degree C temperature compensation of low purity water. The 7082 precisely matches the temperature properties of all common applications automatically, across the full ranges of purity and temperature. Included are the most accurate available temperature compensation algorithms for specific applications: High purity salt, for mixed-bed makeup water and routine monitoring; Cation/Ammonia, for power plant ammonia-treated or cation conductivity/Larson Lane samples; Morpholine, for applicable power plant treatment; and Etch Rinse for semiconductor rinsewater purity measurements.

Cells used with the 7082 have the constant certified and traceable to NBS/ASTM standards. The Cell Calibration Factor is entered into the 7082 to provide readout precisely normalized for the specific cell used.

7082-90 Portable pH Analyzer
(Electrodes, mounting, & preamp ordered separately)

7082-91 Portable Conductivity Analyzer
(Cell and flow chamber ordered separately)

pH The pH Analyzer includes adjustable Solution Temperature Compensation as well as conventional Electrode Temperature Compensation to provide readout of pH referenced to 25C, correcting for changes in ionization with temperature. The Solution Temperature Compensation algorithm is conveniently bypassed during buffer calibration by using the front panel HOLD function. Buffer solutions have their own temperature characteristics identified on the container.

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High Purity accessories include a flowing junction reference electrode. This provides the best transfer of calibration accuracy from standard buffer solutions, with relatively high ionic strength, to the high purity sample, with very low ionic strength. The stainless steel flow chamber provides shielding from stray electrical noise and streaming potentials. The unique L&N "401" electrode option includes a solution ground which provides unsurpassed measurement stability in high purity water.

SPECIFICATIONS

Measurement	pH	Conductivity	Resistivity*
Case Dimensions (closed); WHD	16¼ x 12½ x 9½" (413 x 317 x 241mm)	16¼ x 11 x 9½" (413 x 279 x 241mm)	
Weight (without sensor)	18 lbs (8.2 kg)		
Power	108-132/216-264 Vac, 47-63 Hz, 15 VA memory retained by long-life lithium battery		
Operating & Performance Specifications, see on-line 7082 Analyzer Data Sheet	C2.1211-DS (7082-11)	C2.2211-DS (7082-16)	C2.2211-DS (7082-18)
Temperature Compensation Algorithms	Electrode and Adjustable Solution Temperature Compensation	High Purity Salt, Cation/Ammonia, Morpholine or Uncompensated	High Purity Salt, Etch Rinse or Uncompensated
Ordering Catalog/Part Number	**7082-90** **056433**	**7082-91** **056435**	**7082-92** **056443**

**Field convertible to conductivity*

Required Accessories

High Purity Conductivity Measurements, up to 20 μmho/cm—Power Plants 4973-01-333-20 Cell (See Data Sheet C2.2211-DS)
055919 Flow Chamber

High Purity Resistivity Measurements 4973-001-333-20 Cell (See Data Sheet C2.2211-DS)
055919 Flow Chamber

Routine Conductivity Measurements, up to 2,000 μmho/cm 4973-10-333-20 Cell (See Data Sheet (C2.2211-DS)

Routine Conductivity Measurements, up to 10,000 μmho/cm 4905-50-33-333-20 Cell (See Data Sheet C2.2211-DS)

High Purity pH Measurements 7773-60-5-00-5-401 Electrode Mounting & Preamp (See Data Sheet D2.1119-DS)
117390 Measuring Electrode
008712 Flowing Junction Reference Electrode
834023 6-Conductor Cable (specify 20 feet)

Routine pH Measurements 7777-3-04 Electrode & Preamp (See Data Sheet D2.1134-DS)

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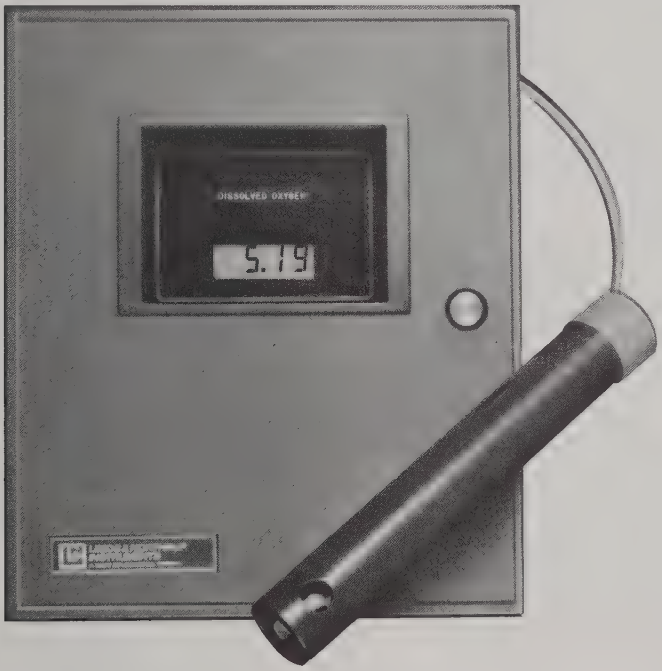
Dissolved
Oxygen

C2.3114-DS

7931 Dissolved Oxygen Analyzer



7931-25 Analyzer and 7931-30 Probe

- **Accurate, continuous monitoring of the true concentration of dissolved oxygen in process or wastewater**
- **Unique patented probe operates independent of inert fouling, independent of flow**
- **Heavy-duty permanent membrane requires no replacement, minimum maintenance**
- **No plating or consumption of electrodes; no mechanical agitation required**
- **Design assures high reliability, long unattended service in adverse environments**
- **Easy calibration against air or liquid**
- **Switch-selected meter display of parts per million or parts per billion, plus air calibration**
- **Analyzer output for control, recording or alarming**

The 7931 Dissolved Oxygen Analyzer assembly, unique in both operation and configuration, comprises a patented probe—unaffected by fouling or changes in flow conditions—and an analyzer mounted in a weatherproof case for outdoor use.

The probe, designed for immersion, insertion or flow-through applications, provides a reading completely independent of diffusion rate through its membrane. This independence permits the use of a heavy-duty silicone-rubber covering to protect the membrane. Compensation is provided for the varying solubility of oxygen with temperature.

The probe assembly is permanently housed in a rugged PVC or 316 SS enclosure which can be mounted on the end of a 1″ pipe for immersion, threaded into the wall of a pipe carrying a flowing sample, or equipped with an inlet and outlet to admit a flow-through sample. Calibration can be checked (using the analyzer) by comparison with either an air or water sample. (Diffusion independence of the probe also simplifies air calibration, since it eliminates drying requirements.)

The analyzer houses the measuring circuit, and a digital display or 4-inch meter for switch-selected indication of dissolved oxygen ranges, temperature and air-calibration point. An isolated current or voltage output and an alarm with relay contacts are also provided.

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APPLICATIONS

Analyzers used in the ppm range measure the concentration of dissolved oxygen in industrial or municipal wastewater streams, lagoons and open water. Typical applications include control of aerated biological processes; monitoring for wastewater-plant influent changes; monitoring wastewater effluent for compliance; control of reservoir aeration systems; early warning of septic conditions; monitoring of navigable waters; and monitoring of fish-hatchery and aqua culture conditions.

Analyzers used in the ppb range measure the concentration of dissolved oxygen in boiler make-up water and other low concentration samples. Typical applications include control of oxygen scavengers; safety alarming for excess oxygen and deaerator efficiency monitoring, to minimize corrosion.

OPERATING PRINCIPLE

The probe consists of three electrodes. Two active platinum electrodes are interspaced on a supporting substrate, and covered with an electrolyte. The third (reference) electrode also contacts the electrolyte, to set the electrochemical potential. The two active electrodes are connected as cathode and anode, and perform oxygen reduction and generation functions. The electrolyte is retained around the electrodes by a gas-permeable membrane, which is covered in turn by silicone rubber.

When the probe is immersed in a sample stream, oxygen diffuses through the membrane and is reduced at the cathode; simultaneously, an equal amount of oxygen is generated at the anode. The diffusion continues until the partial pressure of oxygen on both sides of the membrane is equal and balanced. The current necessary to maintain this equilibrium is converted, by the electrical circuitry at the analyzer, to readout the concentration of dissolved oxygen in the solution.

The chemical reactions are:

At cathode: $O_2 + 4H^+ + 4e^- \rightarrow 2\,H_2O$

At anode: $O_2 + 4H^+ + 4e^- \leftarrow 2\,H_2O$

No oxygen or acid is consumed; no water is produced; no net reaction occurs.

In contrast, other probes work on either the galvanic principle—similar to a small fuel cell—or on the Clark polarographic principle. Both types require a continuous oxygen transfer through the membrane, in a one-way reaction.

The reaction for a Clark-type probe with a lead anode is:

At cathode: $O_2 + 4H^+ + 4e^- \rightarrow 2\,H_2O$

At anode: $2\,PbO + 4H^+ + 4e^- \leftarrow 2\,H_2O + 2\,Pb$

Net Reaction: $O_2 + 2\,Pb \rightarrow 2\,PbO$

The lead anode is consumed, and a continual supply of oxygen is required. Any condition that impedes the flow of oxygen across the membrane into the sensor, such as fouling or insufficient flow, causes the signal to degenerate, resulting in erroneously low readings.

ANALYZER SPECIFICATIONS

Power Requirements Operates on 100-132 V; 50/60 Hz, 20 VA.

Operating Temperature Range −20 to +50 C (−4 to 122 F); 0 to 50 C (32 to 122 F) for 7931-25 display.

Storage Temperature Range −30 to 80 C (−22 to 176 F).

Analyzer Specifications continued

Cat. No.	7931-10	7931-15	7931-20	7931-25
Typical Application	Wastewater		Boiler Water	Wastewater or Boilerwater
Readout	4″ Analog Meter			3½ digit LCD 0.5″ high
Display Ranges (switch selected)	0-5 ppm 0-15 ppm air calibration 0-50° C		0-20 ppb 0-200 ppb 0-20 ppm air calibration	0-20 ppb 0-200 ppb 0-20 ppm 0-100% saturation 0-50°
Readout Resolution	0.1 ppm on 0-5 ppm range; 0.2 ppm on 0-15 ppm range		2.5% of F.S.	1:2000
Alarm	Low*	None	High*	
Output Scaling	Matches Display Range			Matches display range or initial 25% of range, switch selected #

* Alarm may be field modified to interchange high/low operation

# Output scaling may be 0-5, 0-20, 0-50 or 0-200 ppb; 0-5 or 0-20 ppm

Output 4-20 (selectable to 0-16, 4-20, 0-20, 5-25, 0-40 and 10-50) mA dc, isolated; 800 ohm max. load. The 7931-25 has no output on temperature range.

Alarm SPDT rated 120V, 3A inductive. The 7931-15 is shipped without an alarm card. To change from general purpose alarm (standard) to Division II, order one 036597 hermetically sealed Relay to replace the standard relay supplied.

Electrical Connections Two ¾″ conduit openings in bottom of analyzer case; barrier terminal board inside.

Mounting supplied with hardware for panel-, surface- or 1½″ pipe-mounting.

Construction Housed in weatherproof corrosion-resistant NEMA 4X case.

Dimensions Analyzer: Overall, 9⅛″ (W) × 10¾″ (H) × 7⅛″ (D) (232 × 273 × 181 mm); behind front surface of panel, 7⅛″ (W) × 9¾″ (H) × 5⅞″ (D) (181 × 248 × 149 mm).

Weight 8.5 lb. (3.85 kg).

PROBE SPECIFICATIONS

Calibration Oxygen calibration against liquid or air.

Response Time 60 seconds for a 90% response to a step change.

Temperature Compensation Automatic.

Oxygen Consumption Regenerates 99% of all oxygen consumed.

Operating Temperature Range normal: 2-40 C (36-104F); extreme: 2-80 C (36-175 F).

Flow Requirement No dependence on stirring or flow. Max. flow rate when using flow-through probe is 950 mL/min.

Pressure 30 psi (PVC); 50 psi (SS).

Probe Housed in rugged PVC or stainless-steel enclosure, with 20-foot waterproof cable. Cable connects to analyzer with waterproof fitting and spade lugs.

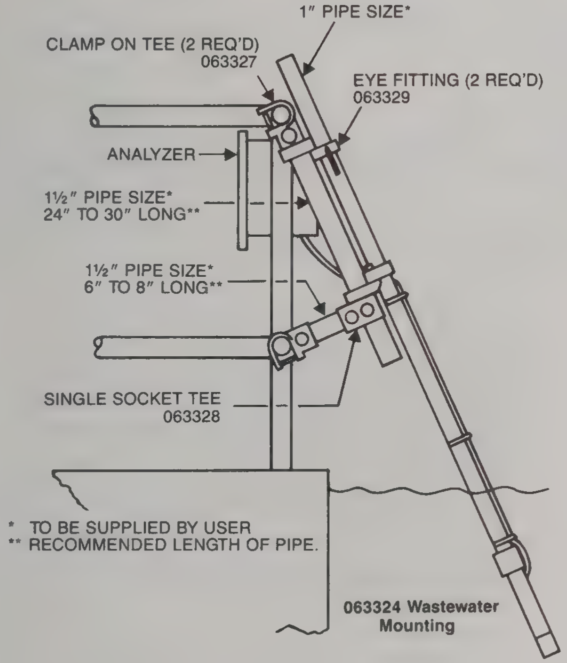
Dimensions 8⅝″ long × 1⁵⁄₁₆″ OD (219 × 34 mm).

Weight PVC: 1.25 lb (0.6 kg); SS 3.5 lb (1.5 kg).

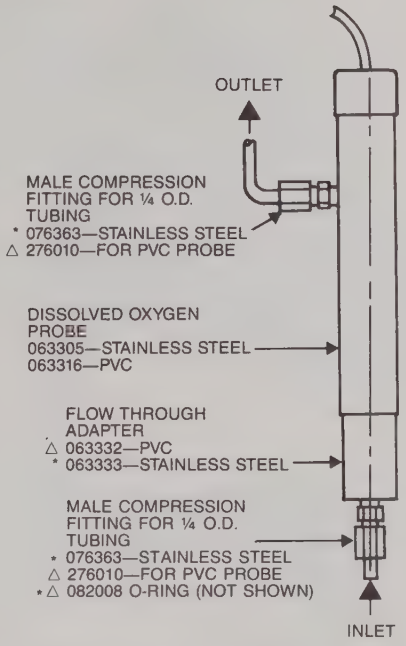
COMBINED ANALYZER/PROBE SPECIFICATIONS

Accuracy PPB measurements: ±5% of full scale on 200 ppb range; ±10% of full scale on 20 ppb range. Accuracy is referenced to current output at calibration conditions, after 24 hours of stabilization.

MOUNTING ACCESSORIES

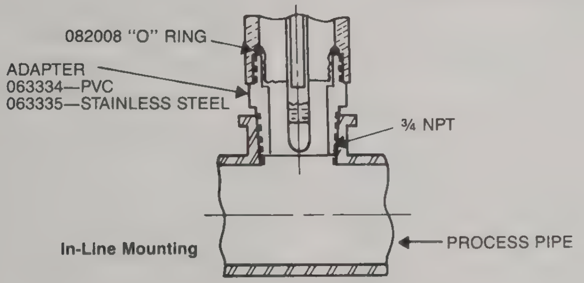

1" PIPE SIZE*
CLAMP ON TEE (2 REQ'D)
063327
EYE FITTING (2 REQ'D)
063329
ANALYZER
1½" PIPE SIZE*
24" TO 30" LONG**
1½" PIPE SIZE*
6" TO 8" LONG**
SINGLE SOCKET TEE
063328
* TO BE SUPPLIED BY USER
** RECOMMENDED LENGTH OF PIPE.

063324 Wastewater Mounting


OUTLET
MALE COMPRESSION FITTING FOR ¼ O.D. TUBING
* 076363—STAINLESS STEEL
△ 276010—FOR PVC PROBE
DISSOLVED OXYGEN PROBE
063305—STAINLESS STEEL
063316—PVC
FLOW THROUGH ADAPTER
△ 063332—PVC
* 063333—STAINLESS STEEL
MALE COMPRESSION FITTING FOR ¼ O.D. TUBING
* 076363—STAINLESS STEEL
△ 276010—FOR PVC PROBE
* △ 082008 O-RING (NOT SHOWN)
INLET

Flow-Through Mounting

063336—PVC (includes items △)
063337—STAINLESS STEEL (includes items *)


082008 "O" RING
ADAPTER
063334—PVC
063335—STAINLESS STEEL
¾ NPT
PROCESS PIPE

In-Line Mounting

ANALYZER/PROBE SPECIFICATIONS continued

PPM measurements: ±1% of full scale. Accuracy is referenced to current output at calibration conditions, after 96 hours of stabilization.

Probe to Analyzer Maximum Distance

ppm measurements: 1000 ft.
ppb measurements: 250 ft.

HOW TO ORDER (select analyzer, probe and mounting kit)

Analyzers	**P/N**
7931-10 (0-5, 0-15ppm) analog	**063300**
7931-15 (0-5, 0-15ppm) analog, without alarm	**062482**
7931-20 (0-20, 0-200ppb; 0-20 ppm) analog	**063301**
7931-25 (0-20, 0-200ppb; 0-20ppm) digital	**063341**
Probes	
7931-30 Polyvinyl Chloride (PVC) body	**063316**
7931-40 316 Stainless Steel body	**063305**

Mounting Kits for Probe

Immersion, fittings for 1½" pipe handrail mounting	**063324**
Flow-Through, for flowing sample, ¼" O.D. tube connections: for PVC probe	**063336**
for SS probe	**063337**
In-Line*, to mount directly in the sample line via ¾" NPT tap: for PVC probe	**063334**
for SS probe	**063335**
***O-Ring** required with in-line adapter	**082008**

Accessories

Probe extension cable Belden 9536, 24 gage, 7 cond., shielded (specify length)	**837032**
Junction Box for 837032 cable	**316260**

Leeds & Northrup

Worldwide Organization to Serve You

Leeds & Northrup equipment is sold and serviced in over 100 major industrial areas throughout the world. Call one of our distribution centers listed below for the location of the Sales & Service facility nearest you.

USA/Canada

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Boston Orchard Hill Office Park, 354 Turnpike Street, Canton, MA 02021; (617) 821-2704

Chicago 7750 West 99th Street, Hickory Hills, IL 60457; (312) 430-1130

Cleveland 24100 Chagrin Boulevard, Beachwood, OH 44122; (216) 292-0020

Dallas 1202 Richardson Drive, Richardson, TX 75080; (214) 234-3363

Denver 4800 Happy Canyon Road, Denver, CO 80237; (303) 759-2701

Houston 15355 Vantage Parkway W., Houston, TX 77032; (713) 590-1777

Los Angeles 265 S. Anita Drive, Orange, CA 92668; (714) 937-1647

New York 2790 Morris Avenue, Union, NJ 07083; (201) 686-5200

Philadelphia 281 Gibraltar Drive, Horsham, PA 19044; (215) 441-5600

Pittsburgh 1910 Cochran Road, Manor Oak 1, Pittsburgh, PA 15220; (412) 561-7808

St. Louis Corporate Hill I, 1655 Des Peres Road, St. Louis, MO 63131; (314) 965-9200

Toronto 1344 Fewster Dr., Mississauga, Ontario, Canada L4W 1A4; (416) 238-6850

Winston/Salem 2554 Lewisville-Clemmons Road, Clemmons, NC 27012; (919) 766-3076

International

Australia 18-20 Mandible Street, Alexandria, N.S.W. 2015, Australia; (612) 699-8400, TLX 21785

England Wharfdale Road, Tyseley, Birmingham B11 2DJ, England; (4421) 706-6171, TLX 336577

France 75-77 Rue du Dr. Vaillant, 78210 St. Cyr l'Ecole, France; (331)34.60.61.61, TLX 698191

Germany Fleher Strasse 32, 4000 Dusseldorf 1, West Germany; (49211) 332-365, TLX 8587436

Ireland Clonshaugh Industrial Estate, Coolock, County Dublin 17, Ireland; (3531) 472-011, TLX 31467

Italy Via Dei Lavoratori, 20092 Cinisello Balsamo, Milano, Italy; (392) 660-0001, TLX 320538

Mexico Blvd. Avila Camacho 225, 53560 Naucalpan de Juarez, Edo de Mexico, Mexico; (905) 576-8033, TLX 1774551

New Zealand 81 Hugo Johnston Drive, Penrose, Auckland, New Zealand; (649) 594481, TLX 60985

Singapore 18 Pasir Panjang Road 08-30, PSA Complex, Singapore 0511; (65) 271-7688, TLX 35051

Spain Jose Rodriquez Pinilla 23/25, 28016 Madrid, Spain; (341) 457-4114, TLX 22953

LEEDS & NORTHRUP
A UNIT OF GENERAL SIGNAL

Instrument & System Solutions!

HEADQUARTERS: Sumneytown Pike, North Wales, PA 19454 USA
PHONE (215) 643-2000 • TELEX 170101 • FAX (215) 699-3702

C2.3114 -DS 80-1287

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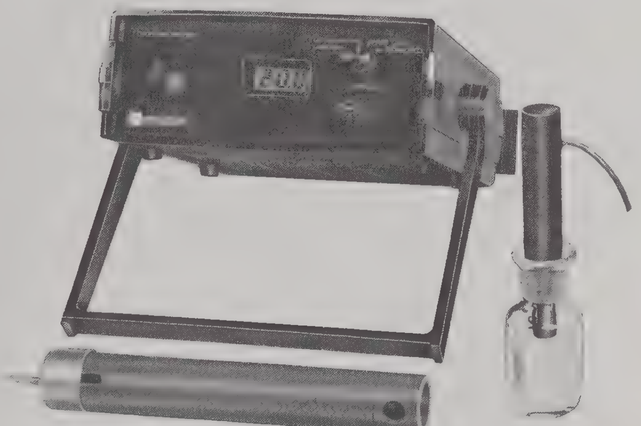
L&N 7932 Portable Dissolved Oxygen Meter

- **Accurate monitoring of the true concentration of dissolved oxygen in wastewater and other liquids**
- **Unique patented probes operate independent of fouling, no stirring required**
- **Permanent membrane sensor requires no routine service, minimum maintenance**
- **No plating, etching or cleaning of electrodes; no contamination of electrolyte; no mechanical agitation required**
- **Design assures high reliability, long service**
- **Easy calibration against air or liquid**
- **Switch-selected digital meter display of 0-20 ppm O_2 range, temperature (0-50 C), or percent O_2 (for calibration)**
- **Millivolt output signal for recording**



The 7932 Dissolved Oxygen Meter system, unique in both operation and configuration, comprises a meter housed in a weatherproof case for indoor or outdoor use, and a patented probe unaffected by fouling or changes in flow conditions.

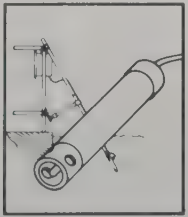
METER

The Meter case is constructed of high-impact-resistant A.B.S. plastic, and joints are gasketed to resist water incursion. Power is supplied by two standard 9-V alkaline batteries, and the unit is designed to be in the "standby" mode, ready for operation at all times, eliminating any stabilization period. (Battery life is up to 60 days on standby.) A low-battery indication is incorporated into the readout, and the circuitry is arranged so that the batteries can be replaced individually, without interrupting the operation.

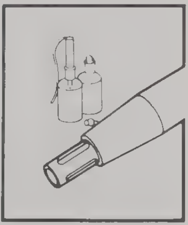
A storage compartment and cable rack are provided on the Meter case to simplify storing or transporting the probe, and a special connector at the rear of the case to accept the probe cable.

PROBES

Submersible Wastewater Probe The wastewater probe assembly is permanently housed in a rugged, high-temperature-resistant PVC enclosure which can be mounted on the end of an extension pipe. Calibration can be checked (using the Meter) by comparison with either an air or water sample. (The diffusion independence of the probe also simplifies air calibration, since it eliminates drying requirements.) The sensor is covered with heavy-duty silicone rubber; a 20-foot waterproof cable, terminating in a waterproof plug-in connector, joins the probe to the Meter.



B.O.D. Probe The body of the B.O.D. probe is formed of rugged high-impact plastic, with a cage-type shield on the immersion end to protect the permanent membrane from damage. The immersion end is tapered to fit the neck of standard B.O.D. bottles. The integral cable, terminating in a plug-in connector for the Meter, is 4 feet long to permit taking measurements from a large number of B.O.D. bottles without having to move them or the Meter.



APPLICATIONS

The 7932 Meter can be used in the field or laboratory to measure the concentration of dissolved oxygen in industrial or municipal wastewater lagoons and open water. Typical applications include:

Monitoring of aerated biological processes;
Measuring wastewater effluent for compliance;
Monitoring reservoir aeration systems;
Profiling navigable water;
Monitoring fish-hatchery conditions;
Corrosion control

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OPERATING PRINCIPLE

The probe consists of three electrodes. Two active electrodes are interspaced on a supporting substrate, and covered with an electrolyte. The third (reference) electrode also contacts the electrolyte, to set the electrochemical potential. The two active electrodes are connected as cathode and anode, and perform oxygen reduction and generation functions. The electrolyte is retained around the electrodes by a gas-permeable membrane, which is covered in turn by silicone rubber.

When the probe is immersed in a sample stream, oxygen diffuses through the membrane and is reduced at the cathode; simultaneously, an equal amount of oxygen is generated at the anode. The diffusion continues until the oxygen tension on both sides of the membrane is equal and balanced. The current necessary to maintain this equilibrium is converted, by the electrical circuitry of the Meter, to a display of the concentration of dissolved oxygen in the solution.

The chemical reactions are:

At cathode: $O_2 + 4H^+ + 4e^- \rightarrow 2\,H_2O$

At anode: $O_2 + 4H^+ + 4e^- \leftarrow 2\,H_2O$

No oxygen or acid is consumed; no water is produced; no net reaction occurs.

In contrast, other probes work on either the galvanic principle—similar to a small fuel cell—or on the Clark polarographic principle. Both types require a continuous oxygen transfer through the membrane, in a one-way reaction.

The reaction for a Clark-type probe with a lead anode is:

At cathode: $O_2 + 4H^+ + 4e^- \rightarrow 2\,H_2O$

At anode: $2\,PbO + 4H^+ + 4e^- \leftarrow 2\,H_2O + 2\,Pb$

Net Reaction: $O_2 + 2\,Pb \rightarrow 2\,PbO$

The lead anode is consumed, and a continual supply of oxygen is required. Any condition that impedes the diffusion of oxygen across the membrane into the sensor, such as fouling or insufficient flow, causes the signal to degenerate, resulting in erroneously low readings.

SPECIFICATIONS

7932 PORTABLE DISSOLVED OXYGEN METER

Concentration Range 0-20.0 ppm dissolved oxygen.

Resolution 0.01 ppm up to 9.99 ppm, 0.1 ppm from 10.0 ppm to 20.0 ppm.

Accuracy Meter and Probe: ±0.2 ppm over temperature range of probe.

Indicator Three-digit liquid crystal display (LCD), highly visible even in direct sunlight.

Ambient Temperature Limits — 10 to +40C (14 to 104F) probe must not freeze.

Output 0-100 mV

Controls (I) Four-position switch, for selection of (a) standby, (b) oxygen measurement (0-20.0 ppm), (c) air calibration (%O_2) and (d) temperature measurement (0-50 C) from thermistor in probe. (II) Ten-turn calibration adjustment.

Power Requirement Operates on two standard 9-V alkaline batteries. Battery life: 60 days on standby, 20 days on continuous operation. Low-battery indication is provided in display.

Case Suitable for field use; includes storage compartment for probe and rack for cable. Pivoted support stand elevates front of case to facilitate readings and adjustments.

Dimensions Overall: 4″ (h) × 10″ (w) × 12″ (d) (10.2 × 25.4 × 30.5 cm).

Weight 3.5 lb (1.5 kg).

DISSOLVED OXYGEN PROBES

Response Time Submersible Probe: 60 seconds for 90% response to a step-change, using a clean sensor. BOD Probe: 25 seconds for 90% response.

Calibration Oxygen calibration is against either liquid standard or air.

Temperature Range Submersible Probe: For rated accuracy 2 to 40 C (36 to 104 F); extreme 2 to 80 C (36to176 F). BOD Probe: for rated accuracy 4 to 30 C (39 to 86 F); excursions to 50 C (122 F). DO NOT FREEZE.

Temperature Compensation Automatic, over operating temperature range.

Flow Requirement No minimum flow requirement; no agitation or stirring required.

Oxygen Consumption Regenerates 99% or more of all oxygen consumed.

Electrode Life No theoretical limitation, since there is no plating or consumption of electrodes.

Electrolyte Permanent electrolyte, sealed with an expansion chamber to compensate for pressure changes.

Internal Construction Three electrodes (anode, cathode, reference electrode) and a thermistor for temperature compensation.

Electrical Connection Integral waterproof cable, terminating in a waterproof 9-pin quick-disconnect plug.

Dimensions Submersible Probe: 8¾″ long × 1⁵⁄₁₆″ OD (222 × 33 mm), with 20 ft. (6.1 m) integral cable. BOD Probe: 5¼ L × ⅞″ OD (134 × 23 mm).

Weight 1.25 lb (0.6 kg).

HOW TO ORDER

1. To order a 7932 Portable Dissolved Oxygen Meter, specify L&N Part Number 062493.
2. To order a wastewater probe with integral 20 ft. cable, specify L&N Part Number 063340.
3. To order a B.O.D. probe with integral 4 ft. cable and tapered neck to fit B.O.D. bottles, specify L&N Part Number 062492.

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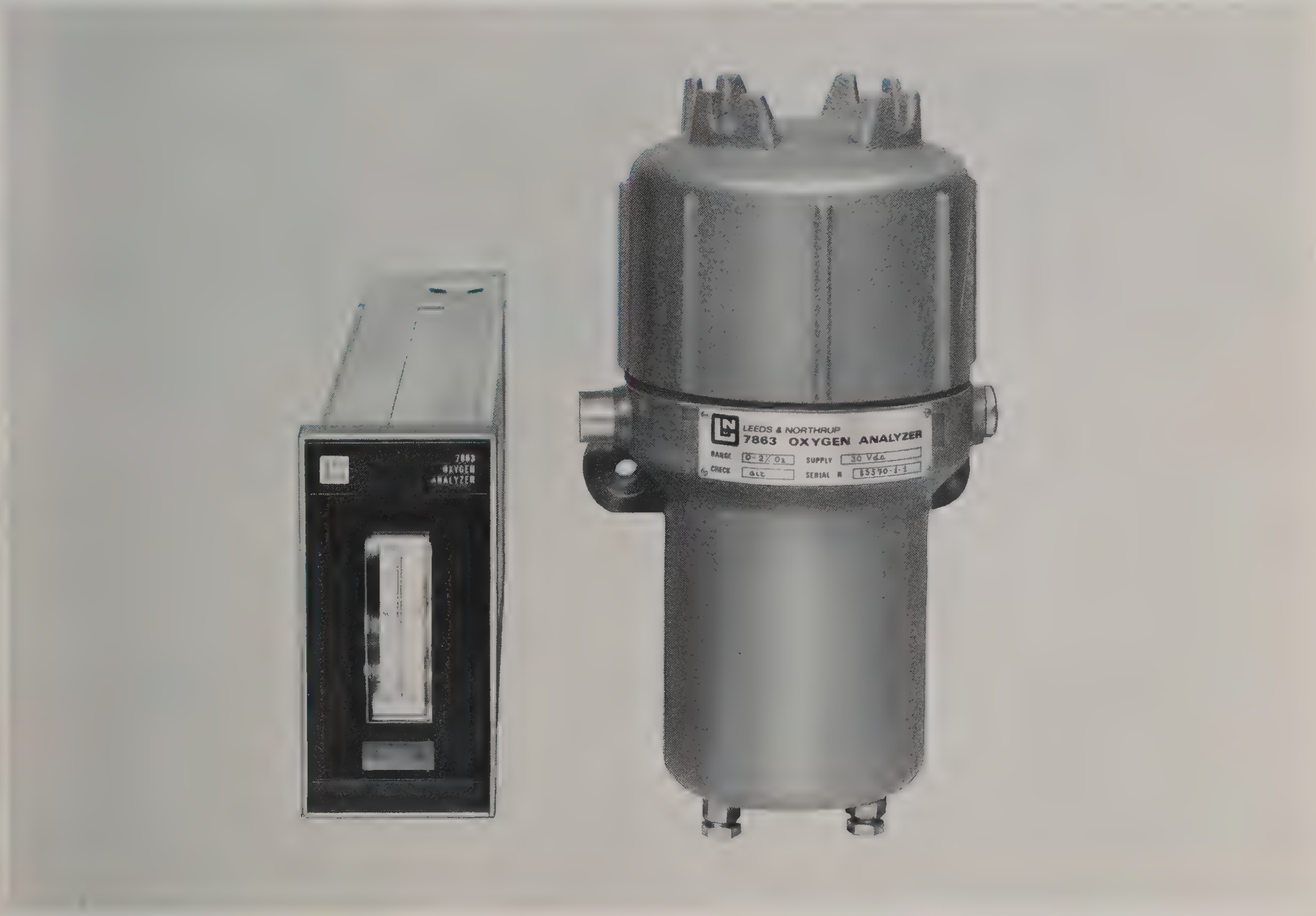
C3.1121-DS

Another Member of L&N's Family of Gas Analyzers

7863 Thermomagnetic Oxygen Analyzer


7863
OXYGEN
ANALYZER
LEEDS & NORTHRUP
7863 OXYGEN ANALYZER
RANGE
CHECK
SUPPLY 30 Vdc
SERIAL #

- High speed of response
- High sensitivity
- Excellent stability
- Reliable solid state design
- Lower installation costs through optional remote mounting capability of the Sensing Unit (Transmitter)
- General-purpose or explosion-proof housing of the Sensing Unit
- Signal transmission from the Sensing Unit up to 1000 feet over unshielded leadwires
- Panel-mounted Control Unit (Receiver)
- Standard 30 V d-c supply voltage to the field-mounted Sensing Unit
- Control Unit indicating meter
- Voltage or current output signals from the Control Unit
- Single or optional dual alarms with digital thumbwheel setters
- Optional switch selectable dual-range capability

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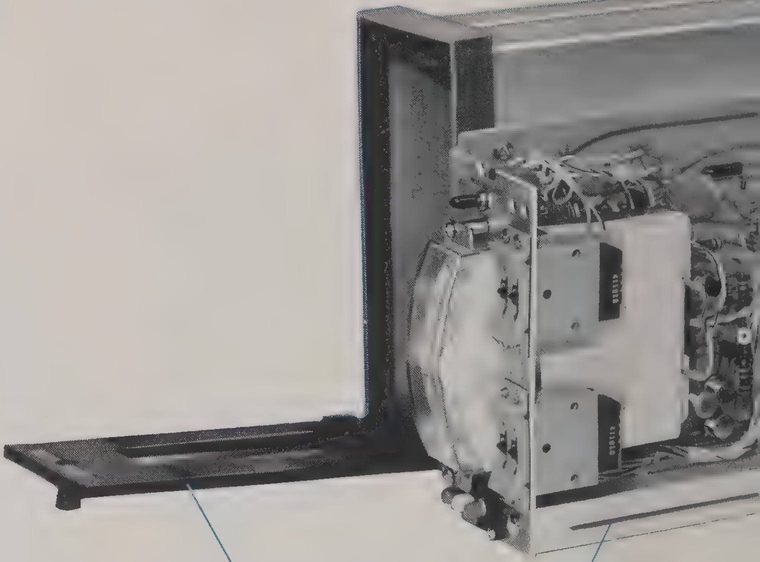
7863 Thermomagnetic Oxygen Analyzer

Field-Mount the Transmitter up to 1000 Feet from the Control Unit



FLIP-DOWN DOOR, MAGNETICALLY LATCHED, FOR EASY ACCESSIBILITY

CHASSIS SLIDES OUT OF CASE FOR ROUTINE MAINTENANCE WHEN REQUIRED.

The Leeds & Northrup 7863 Thermomagnetic Oxygen Analyzer, taking advantage of the paramagnetic properties of oxygen and the diamagnetic properties of most other industrial gases, uses these magnetic effects to provide a highly sensitive and accurate analysis of the concentration of uncombined oxygen in various background gases.

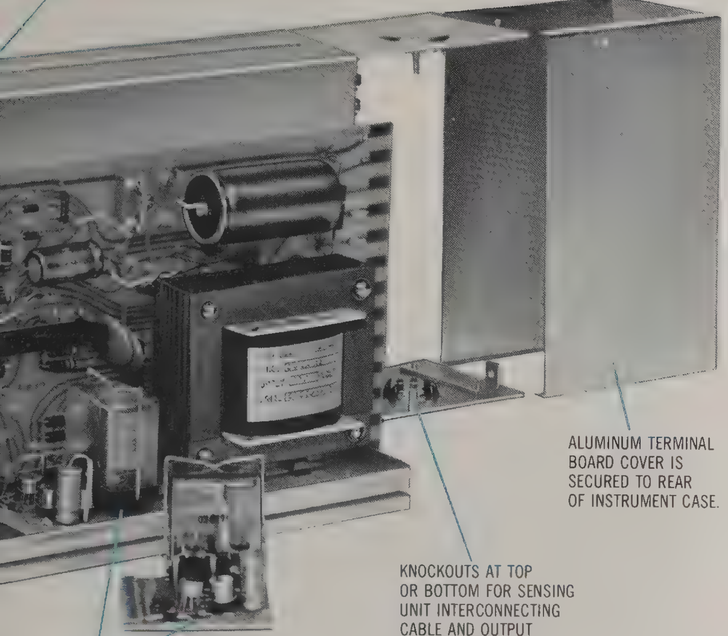
The paramagnetic material is one which is attracted by a magnetic field, while a diamagnetic material is repelled. Oxygen is one of the few gases which is paramagnetic. (Nitric oxide is the only other strongly paramagnetic common gas.) The magnetization produced by a magnetic field of unit strength in a paramagnetic gas varies inversely as the absolute temperature. Therefore, by properly combining a magnetic field gradient and a thermal gradient, it is possible to induce and sustain a flow of paramagnetic gas in a confined system. In a gas analyzer where other paramagnetic gases are not present, the intensity of the gas flow thus produced (other factors being constant) is dependent upon the concentration of oxygen in the gas sample. Changes in the intensity of magnetically-induced gas flow are then used as a measure of the concentration of the oxygen component. In the thermomagnetic method, the changes in intensity of gas flow are measured by the effect produced upon the resistance of a temperature-sensitive element, a thermistor.

The Sensing Unit receives a continuous flow of the gas mixture, measures the concentration of oxygen, and transmits an electrical signal to the Control Unit. The Sensing Unit is ruggedly constructed to meet most environmental conditions, and is designed to be mounted up to 1,000 feet from the Control Unit with only a single multi-conductor non-shielded cable connecting the two, resulting in greater flexibility and lower installation costs.

Some of the typical applications for the 7863 Thermomagnetic Oxygen Analyzer are:

INDUSTRY	APPLICATION
Electric Power	Control fuel/air ratio in steam generation.
Primary Metals	Guide to combustion efficiency on reheat and open hearth furnaces; also oxygen concentration in heat treating and annealing furnaces.
Chemical	Measuring and maintaining safe levels of oxygen in combustible mixtures.
Petroleum	Measurement and control of oxygen in catalyst regeneration; also detection of oxygen impurities in inert gases.
Cement and Ceramic	Control fuel/air ratio in rotary kilns.

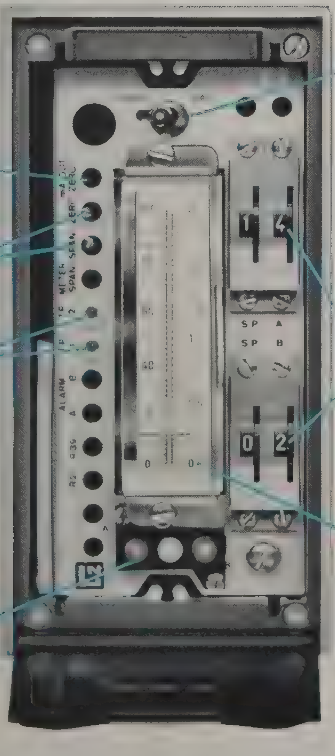
EXTRUDED ALUMINUM CASE
DESIGNED FOR EASY PANEL MOUNTING.



ALUMINUM TERMINAL
BOARD COVER IS
SECURED TO REAR
OF INSTRUMENT CASE.

KNOCKOUTS AT TOP
OR BOTTOM FOR SENSING
UNIT INTERCONNECTING
CABLE AND OUTPUT
SIGNAL CONDUCTORS.

ALARM OUTPUT
RELAYS WITH
FAILSAFE FEATURES.



"MEASURE/CALIBRATE"
SWITCH FOR INPUT
GAS SELECTION

CURRENT-OUTPUT
ADJUSTMENT

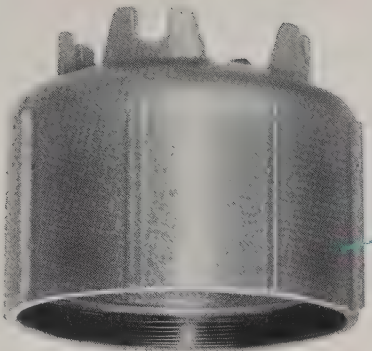
ZERO AND SPAN
ADJUSTMENTS FOR
EASY CALIBRATION

OUTPUT-CIRCUIT
TEST POINTS

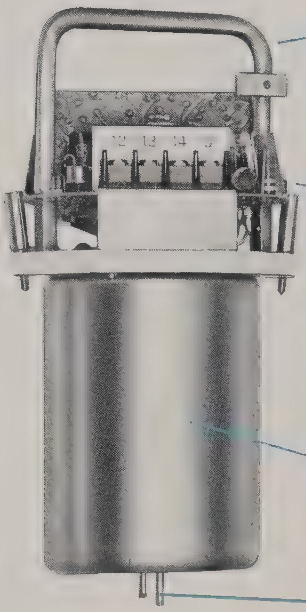
DIGITAL ALARM
SET-POINT SETTERS

INDICATING
METER FOR READOUT
IN PERCENT
CONCENTRATION

ALARM
INDICATION LAMPS



RUGGED THREADED
CAP SEATS ON
GASKETED HOUSING.



STAINLESS-STEEL
HANDLE FACILITATES
REMOVAL OF
SENSOR ASSEMBLY.

CELL-BLOCK
ELECTRONICS
ASSEMBLY.

STAINLESS-STEEL
CELL-BLOCK ASSEMBLY.

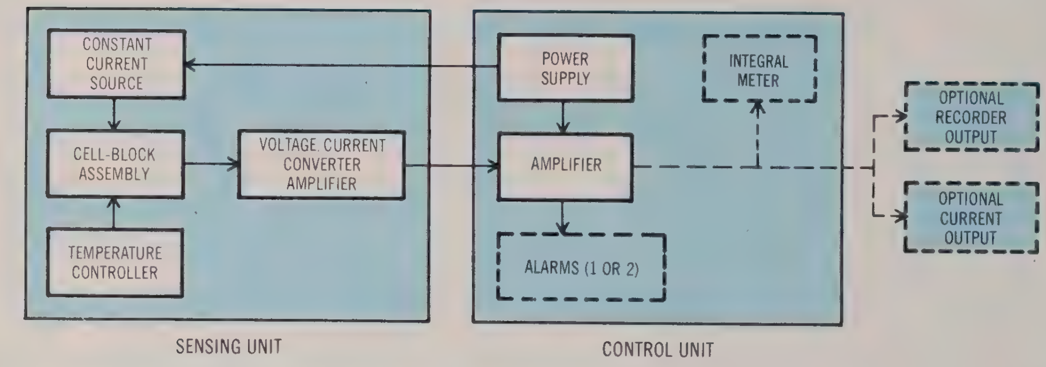
INLET AND OUTLET
PORTS TO MEASURING
AND REFERENCE CELLS.

7863
ANALYZER
30V

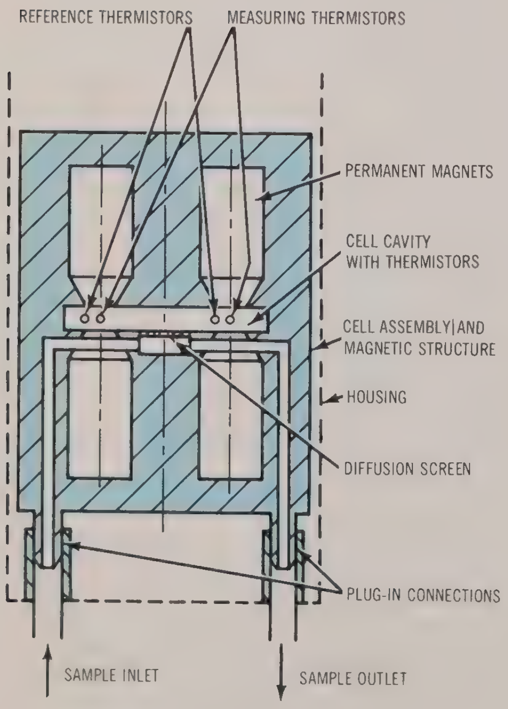
RUGGED, GENERAL-
PURPOSE WATERPROOF
AND DUST PROOF
CAST-ALUMINUM
HOUSING.

INLET AND OUTLET PORTS FOR SAMPLE GAS.

Reliable Solid State Circuit Design Plus Simplified Modular Construction Add Up to Minimum Downtime and Easy Routine Maintenance.


CONSTANT CURRENT SOURCE
CELL-BLOCK ASSEMBLY
TEMPERATURE CONTROLLER
VOLTAGE CURRENT CONVERTER AMPLIFIER
POWER SUPPLY
INTEGRAL METER
AMPLIFIER
ALARMS (1 OR 2)
OPTIONAL RECORDER OUTPUT
OPTIONAL CURRENT OUTPUT
SENSING UNIT
CONTROL UNIT

Block Diagram of 7863 Thermomagnetic Oxygen Analyzer


REFERENCE THERMISTORS
MEASURING THERMISTORS
PERMANENT MAGNETS
CELL CAVITY WITH THERMISTORS
CELL ASSEMBLY|AND MAGNETIC STRUCTURE
HOUSING
DIFFUSION SCREEN
PLUG-IN CONNECTIONS
SAMPLE INLET
SAMPLE OUTLET

Cross-Section of Sensing Unit

Sensing Unit

The 7863 Thermomagnetic Oxygen Analyzer's Sensor Assembly can be supplied in a general-purpose or explosion-proof housing. Both types of housing are of rugged cast-aluminum construction which permits reliable operation under adverse ambient conditions.

The CELL BLOCK ASSEMBLY is of stainless-steel construction and contains the cell cavity and pole pieces which produce two powerful magnetic fields in the cavity. Associated with each field is a thermistor pair, consisting of a measuring thermistor and a reference thermistor. The measuring thermistor is mounted in the cavity within its respective magnetic zone; the corresponding reference thermistor is mounted in the cavity just outside its magnetic zone. A sample inlet port and a sample outlet port are arranged to permit a portion of the flowing sample to diffuse into the cavity, where it comes under the influence of thermal gradients and magnetic fields. The effect of the resulting thermomagnetic effect on the temperature sensing thermistors provides the measuring means.

The Sensing Unit's ELECTRONICS ASSEMBLY incorporates some of the solid state electrical circuits. These circuits include:

Current Regulator — which supplies the constant current to the thermistor cell bridge circuit.

Proportional Action Temperature Controller — which maintains the entire cell block at a constant temperature.

Voltage to Current Converter/Amplifier — whose current output is transmitted to the analyzer's Control Unit.

Control Unit

The Control Unit houses the remaining measuring and power-supply circuits in an extruded aluminum DIN standard case. In addition, the Control Unit contains the front-panel calibration adjustments for the analyzer system. These include the zero and span adjusters, and a span adjuster for the readout meter. A front-panel switch permits manually transferring the input to the Unit from sample gas to air for easy calibration. Test points for the Control Unit's output circuits are also provided.

Integral Readout Meter on the Control Unit: This meter, mounted on the front-panel of the Control Unit, provides a continuous readout indication in percent concentration of oxygen.

Single or Dual Alarms: A single alarm (Hi or Lo) or optional dual alarms (one Hi and one Lo, two Hi, or two Lo) can be provided. The alarm consists of a digital thumbwheel set-point setter for each alarm level, an indicating lamp which is lit when an alarm is detected, and a relay output that can be used to actuate an external annunciator or to start a process shutdown device.

Performance Specifications

Accuracy: ±1% of span (output signal).

Linearity: Within ±2% of span for most standard ranges. Linearity correction data is supplied in Direction Book 177950, Appendix C.

Meter: Accuracy: ±2.5% of span. Deadband: Less than 0.5% of span. Scale Length: 2-9/32″ (58.5 mm).

Repeatability: Short Term: ±0.3% of span.

Reproducibility: 24 Hours: ±1% of span.

Response Time: Maximum for 2.1 cfh (1000 cc/min) flow: Initial, less than 1 second; 90% of step-change, 1 minute.

Drift: Zero: ±2% of span per week, maximum. Span: ±1% of span per week, maximum.

Ambient Temperature Influence: At Sensing Unit: ±0.0012% O_2 per °F or ±0.039% of span per °F, whichever is greater (±0.002% O_2 per °C or ±0.07% of span per °C, whichever is greater.)

At Control Unit: ±0.005% of span per °F (±0.01% of span per °C).

Atmospheric Pressure Influence: ±0.46% of full scale per inch H_2O (±0.25% of full scale per mm Hg).

Sample Flow-Rate Influence: Less than 0.5% of span over flow range of 0.5 to 2.1 cfh (250 to 1000 cc/min).

Line Voltage Influence: 0.02% of span, maximum, for each 1% change of voltage.

Gas Interference: Less than ±0.01% O_2 per 1% CO_2 (to 50% CO_2, max.); ±0.07% O_2 per 1% H_2 (to 10% H_2, max.); ±0.007% O_2 per 1% H_2O; ±0.75% of span per 1% SO_2, typical.

Operating Specifications

Measuring Range (One or two ranges, as specified; dual range must be two zero-based ranges):

0-2%	0-10%	0-25%
0-5%	0-15%	15-25%*
0-7.5%	0-20%	20-30%*

An air-calibrate range with "20.85% O₂" marked on the meter scale is included (except for ranges with "*") and permits a convenient calibration check with an air sample.

Output (Non-isolated):
0-20 mA into 0-500 ohm load
4-20 mA into 0-500 ohm load
0-10 mV across 5000-ohm minimum load
0-100 mV across 50,000-ohm minimum load
0-1 V across 120,000-ohm minimum load
0-10 V across 2000-ohm minimum load

Alarm Circuits:
Set Point Resolution: 1% of span
Contact Ratings: 3 amps at 120 V a-c (resistive) or 28 V d-c (resistive); SPDT, failsafe design

Sample Requirements:
Sample Flow: 0.5 to 2.1 cfh (250 to 1000 cc/min.)
Sample Pressure: 20″ H_2O (37 mm Hg) minimum (with filter and flowmeter)

Ambient Requirements:
Relative Humidity: 90% maximum
Temperature Range: 14 F to 122 F (−10 C to +50 C)
Storage Temperature: 158 F (70 C maximum)

Power Requirements: (Control Unit Only)
Line Voltage: 117 V ±10 V or 230 V ±20 V, 50/60 Hz, 40 Watts

Physical Specifications

Material Contacting Sample Gas: Sample contacts 316, 303 and 430 stainless steel, platinum-iridium, Chromel, Tefzel, Viton and glass.

Sensing Unit:

Weight: General-Purpose—15 lb (7 kg). Explosion-Proof—18¾ lb (8.5 kg).

Dimensions: General-Purpose—Approx. 6″ × 6″ × 11½″ (150 × 150 × 290 mm). Explosion-Proof—Approx. 6″ × 6″ × 12¾″ (150 × 150 × 325 mm).

Finish: Gray textured enamel.

Position Requirement: Must be mounted within 30° of vertical.

Control Unit:

Weight: 6½ lb (3 kg).

Dimensions: DIN standard case, 2⅞″ × 5⅝″ × 15″ (72 × 144 × 385 mm).

Finish: Gray textured enamel (bezel), black enamel (front plate), extruded aluminum case.

Readout: Optional integral meter with direct-reading scale.

Connections:
Sample Inlet and Outlet: ¼″ OD tubing (compression fittings supplied)
Reference Gas Inlet and Outlet: ¼″ OD tubing (compression fittings supplied)
Electrical Power Inlet: Opening for ½″ Conduit (control unit only)
Sensing Unit Power Inlet (30 V d-c from control unit): ½″ NPT (female Conduit)

Miscellaneous:
General Purpose Sensing Unit: NEMA 4 (water-tight and dust-tight).
Explosion-Proof Sensing Unit: Designed to meet NEMA 7, Class I, Division I, Group A, B, C & D
Control Unit: NEMA 1 (general purpose indoor)
Analyzer Temperature: Sensing Unit thermostated at 122 F (50 C)

Ordering Information

Catalog Numbering System:

A B C D E F G H L M
7863–☐–☐–☐–☐☐☐–**1**–**2**–☐–☐☐–☐–☐☐☐–☐☐☐

Suffix A — Line Voltage:
2 230 V 50/60 Hz
4 115 V 50/60 Hz

Suffix B — Output Signal:
1 0-20 mA
2 4-20 mA
3 0-10 V
4 0-1 V
5 0-100 mV
6 0-10 mV

Suffix C — Stream Composition:
1 For Combustion Processes
9 For Non-combustion Processes

Suffix D — Range
002 0-2% O_2
005 0-5% O_2
007 0-7.5% O_2
010 0-10% O_2
015 0-15% O_2
020 0-20% O_2
025 0-25% O_2
125 15-25% O_2
230 20-30% O_2
992 Dual Ranges (Specify 2 Zero-Based Ranges and Single Scale Desired)
999 Special Ranges (as Specified)

Suffix E — Integral Meter on Control Unit:
1 Meter Included

Suffix F — Control Unit:
2 Complete Control Unit Assembly

Suffix G — Sensing Unit:
1 With General-Purpose Housing
3 With Explosion-Proof Housing

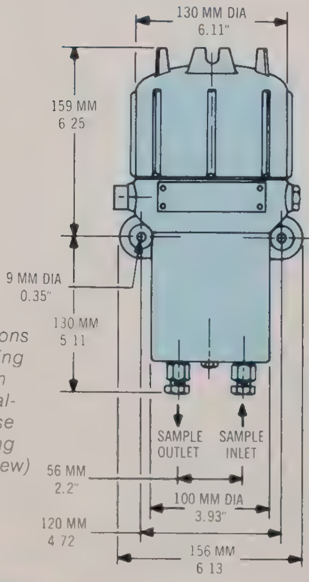
Suffix H — Alarms:
01 One Low Alarm (Suffix L must be "0")
02 One High Alarm (Suffix L must be "0")
03 One High, One Low Alarm
04 Two Low Alarms
05 Two High Alarms

Suffix L — Alarm Connections at Terminal Board
0 Standard: With One Alarm, 1 SPDT; With Two Alarms, 2 SPDT Non-Isolated
1 One SPDT and one SPST (NC), Isolated
2 One SPDT and one SPST (NO), Isolated

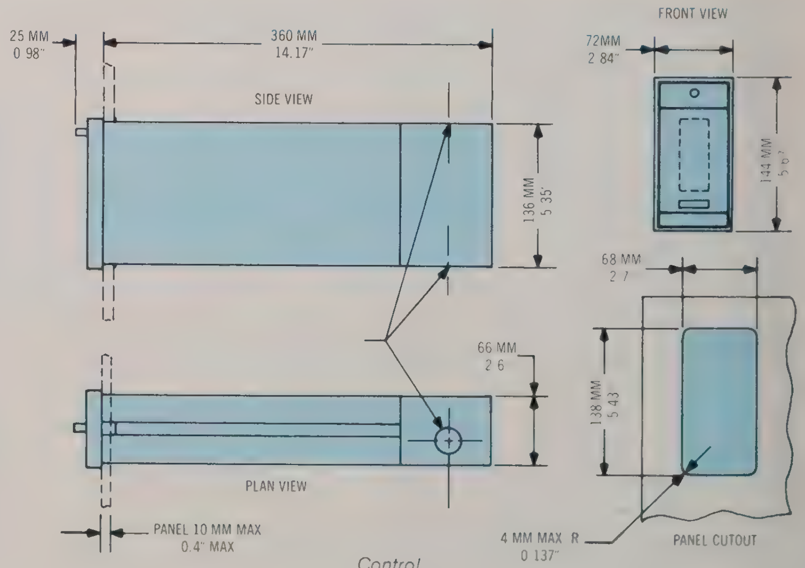
Suffix M — Optional Features (Omit suffix is not required)
206 Linen Tags (15 characters max. on each of three lines: specify legend). One mounted on Control Unit, one on Sensing Unit.
208 Stainless Steel Tags (22 characters max. on each of three lines: specify legend) One Mounted on Control Unit, one on Sensing Unit.
239 Engraved Nameplate (20 characters max. on each of two lines: specify legend) mounted on front face of Control Unit.
155 Solenoid valve for remote switching to calibration air.

Sampling Systems:

Prepackaged 7872-Series Sampling Systems appropriate to the application are available; contact your local L&N office for details.


130 MM DIA
6.11"
159 MM
6 25
9 MM DIA
0.35"
130 MM
5 11
SAMPLE OUTLET
SAMPLE INLET
56 MM
2.2"
100 MM DIA
3.93"
120 MM
4 72
156 MM
6 13

Dimensions of Sensing Unit in General-Purpose Housing (Front View)


25 MM
0 98"
360 MM
14.17"
SIDE VIEW
136 MM
5 35"
FRONT VIEW
72MM
2 84"
144 MM
5 67
68 MM
2 7
66 MM
2 6
138 MM
5 43
PLAN VIEW
PANEL 10 MM MAX
0.4" MAX
4 MM MAX R
0 137"
PANEL CUTOUT

Control Unit Dimensions

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A UNIT OF GENERAL SIGNAL

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C3.1111-DS

Another Member of L&N's Family of Gas Analyzers

7866 Thermal Conductivity Analyzer for Binary Gas Mixtures

7866 THERMAL CONDUCTIVITY ANALYZER
7866 THERMAL CONDUCTIVITY ANALYZER

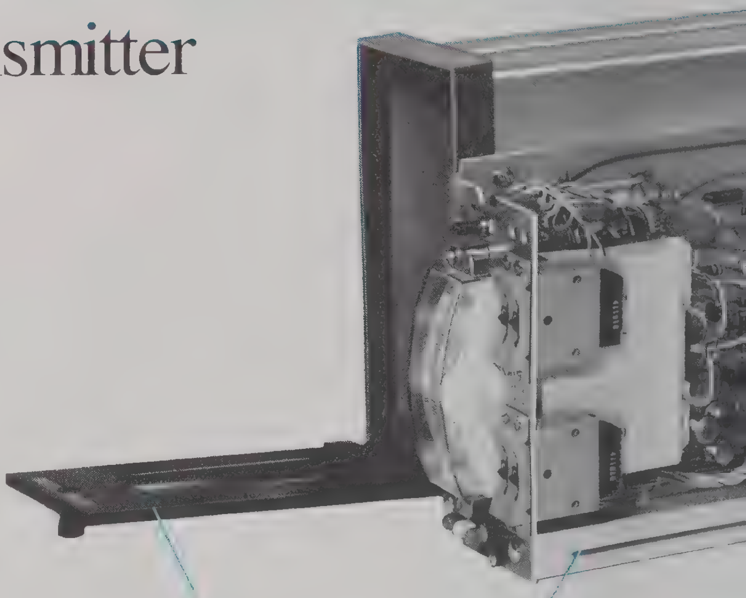
- High speed of response
- High sensitivity
- Excellent stability
- Reliable solid state design
- Lower installation costs through optional remote mounting capability of the Sensing Unit (Transmitter)
- General-purpose or explosion-proof housing of the Sensing Unit
- Signal transmission from the Sensing Unit up to 1000 feet over unshielded leadwires
- Panel-mounted Control Unit (Receiver) with indicating meter
- Optional triple range for hydrogen-cooled generator applications
- Standard 30 V d-c supply voltage to the field-mounted Sensing Unit
- Voltage or current output signals from the Control Unit
- Single or dual alarms with digital thumbwheel setters
- Optional switch-selectable dual-range capability

LEEDS & NORTHRUP
A UNIT OF GENERAL SIGNAL

Instrument & System Solutions!

7866 Thermal Conductivity Analyzer

Field-Mount the Transmitter up to 1000 Feet from the Control Unit

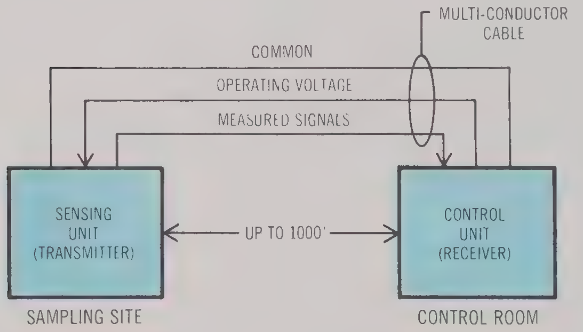


FLIP-DOWN DOOR, MAGNETICALLY LATCHED, FOR EASY ACCESSIBILITY

CHASSIS SLIDES OUT OF CASE FOR ROUTINE MAINTENANCE WHEN REQUIRED.

The Leeds & Northrup Catalog 7866 Thermal Conductivity Analyzer is designed to provide a highly sensitive and accurate analysis of a binary (two component) mixture of gases. The analyzer can also be calibrated to measure a single component of a multi-component gas mixture, providing the background gases constitute a stable mixture (such as air), or have approximately the same thermal conductivity.

The 7866 Analyzer, utilizing the principles of thermal conductivity, determines the concentration of a sample gas through the measurement of thermal losses from two highly-stable, matched thermistor probes inserted in a stainless steel block.



The analyzer consists of two basic components — the Sensing Unit (Transmitter) and the Control Unit (Receiver).

The Sensing Unit receives a continuous flow of the binary or multi-component gas mixture, measures the concentration of the sample gas, and transmits an electrical signal to the Control Unit. The Sensing Unit is ruggedly constructed to meet most environmental conditions, and is designed to be mounted up to 1,000 feet from the control unit with only a single multi-conductor non-shielded cable connecting the two, resulting in greater flexibility and lower installation costs.

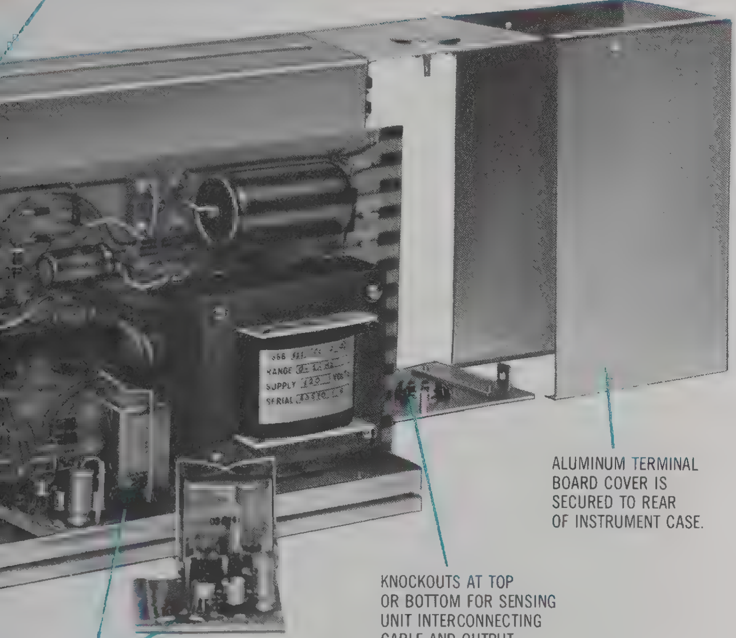
The Control Unit receives the output signal from the Sensing Unit at the sampling site by way of the interconnecting cable. The same cable supplies the operating voltage (30 V d-c) to the Sensing Unit from the Control Unit.

The Control Unit is designed for simplified panel-mounting either at the sampling site, if environmental conditions permit or in a control room. The Unit can provide a voltage of current output signal to an auxiliary instrument such as a strip-chart recorder, and, if desired, can be equipped with an indicating meter for direct readout and monitoring of the sample gas concentration. The Control Unit can also be supplied with one or two optional alarms with digital thumbwheel setpoint setters. When an alarm is detected a relay contact is energized to activate an external annunciator or auxiliary relay to initiate a shutdown procedure for the process. The relay is inherently failsafe since it is normally energized and provides a contact closure on loss of power.

Some of the common applications of the 7866 Thermal Conductivity Analyzer are:

INDUSTRY	APPLICATION
Electric Power	Power Plants: accurate monitoring of hydrogen purity in hydrogen cooled generators. The Triple Range Analyzer also monitors carbon dioxide in air and carbon dioxide in hydrogen insuring safe execution of the purge cycles.*
Steel	
Chemical	Ammonia Plants: measurement of hydrogen in ammonia, nitrogen, oxygen, carbon monoxide or argon.
Petroleum	Measurement of hydrogen in certain hydrocarbon streams.

*See also Data Sheet C3.1112-DS

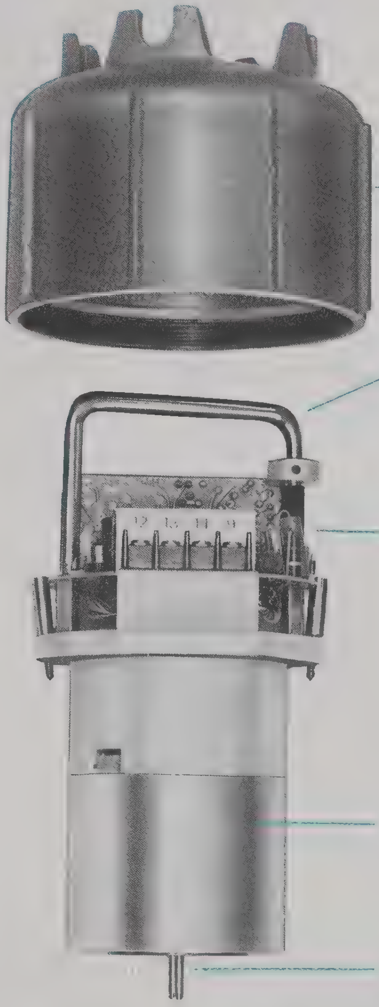


EXTRUDED ALUMINUM CASE
DESIGNED FOR EASY PANEL MOUNTING.

ALUMINUM TERMINAL
BOARD COVER IS
SECURED TO REAR
OF INSTRUMENT CASE.

KNOCKOUTS AT TOP
OR BOTTOM FOR SENSING
UNIT INTERCONNECTING
CABLE AND OUTPUT
SIGNAL CONDUCTORS.

ALARM OUTPUT
RELAYS WITH
FAILSAFE FEATURES.



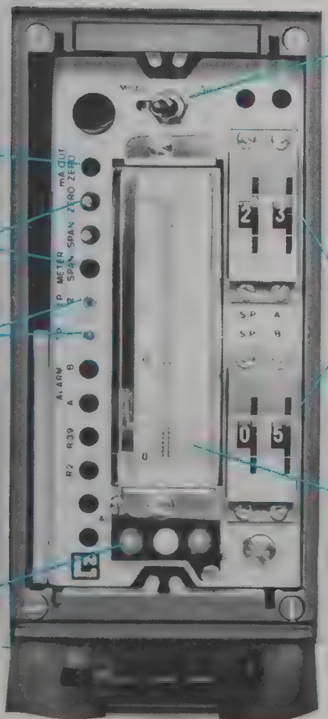
RUGGED THREADED
CAP SEATS ON
GASKETED HOUSIN

STAINLESS-STEEL
HANDLE FACILITATE
REMOVAL OF
SENSOR ASSEMBLY

CELL-BLOCK
ELECTRONICS
ASSEMBLY.

STAINLESS-STEEL
CELL-BLOCK ASSEMBLY.

INLET AND OUTLET
PORTS TO MEASURING
AND REFERENCE CELLS.



"MEASURE/CALIBRATE"
SWITCH FOR INPUT
GAS SELECTION

CURRENT-OUTPUT
ADJUSTMENT

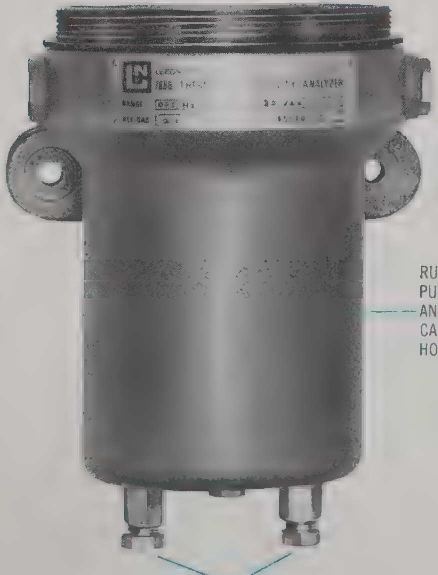
ZERO AND SPAN
DJUSTMENTS FOR
ASY CALIBRATION

OUTPUT-CIRCUIT
TEST POINTS

DIGITAL ALARM
SETPOINT SETTERS

OPTIONAL INDICATING
METER FOR READOUT
OF PERCENT
CONCENTRATION

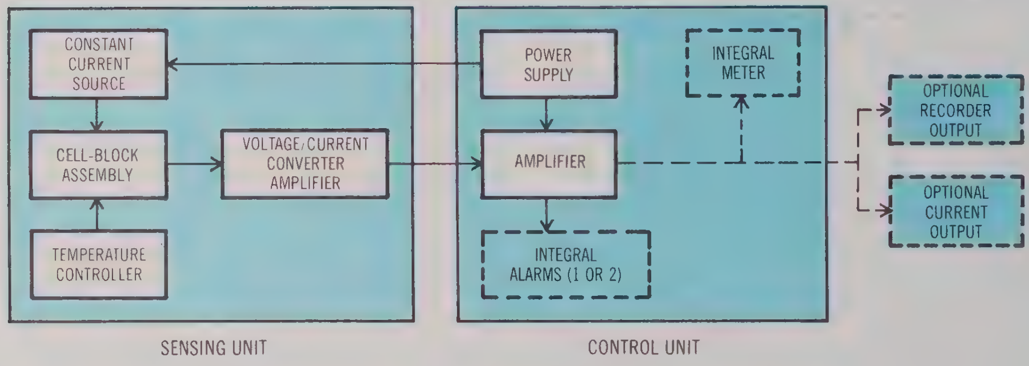
ALARM
NDICATION LAMPS



RUGGED, GENERAL-
PURPOSE WATERPROOF
AND DUST PROOF
CAST-ALUMINUM
HOUSING.

INLET AND OUTLET PORTS FOR SAMPLE GAS

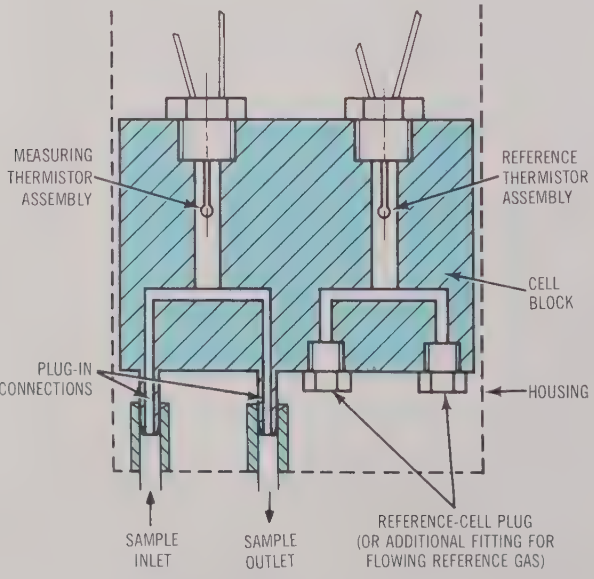
Reliable Solid State Circuit Design Plus Simplified Modular Construction Add Up to Minimum Downtime and Easy Routine Maintenance.


CONSTANT CURRENT SOURCE
CELL-BLOCK ASSEMBLY
TEMPERATURE CONTROLLER
VOLTAGE/CURRENT CONVERTER AMPLIFIER
POWER SUPPLY
INTEGRAL METER
AMPLIFIER
INTEGRAL ALARMS (1 OR 2)
OPTIONAL RECORDER OUTPUT
OPTIONAL CURRENT OUTPUT
SENSING UNIT
CONTROL UNIT

Block Diagram of 7866 Thermal Conductivity Analyzer

Sensing Unit

The 7866 Thermal Conductivity Analyzer's Sensor Assembly can be supplied in a general-purpose or explosion-proof housing. Both types of housing are of rugged cast-aluminum construction which permits reliable operation under adverse ambient conditions.


MEASURING THERMISTOR ASSEMBLY
REFERENCE THERMISTOR ASSEMBLY
CELL BLOCK
PLUG-IN CONNECTIONS
HOUSING
SAMPLE INLET
SAMPLE OUTLET
REFERENCE-CELL PLUG (OR ADDITIONAL FITTING FOR FLOWING REFERENCE GAS)

Cross-Section of Sensing Unit

The Sensor Assembly comprises two sections — the cell block assembly and the electronics assembly.

The CELL BLOCK ASSEMBLY is of stainless steel construction with two identical internal cells: the measuring cell and the reference cell. A highly stable thermistor is mounted in each cell. These matched thermistors form the active arms of a bridge circuit: the unbalanced current of the bridge provides the means of measuring the relative ability of the sample and reference gases to conduct heat away from their respective thermistors to the cell wall, which is held at a constant temperature. The reference gas chamber, with inlet and outlet openings drilled into the chamber from the base, may be open or sealed. All zero-based standard ranges and the 20% to 50% H_2 range have air-filled, sealed reference cells. For hydrogen ranges starting above 50%, and the 98-100% oxygen range, a flowing reference is used. The measuring chamber is open to the continuous sample-gas flow.

The cells in which the thermistors are mounted are dead-ended so the sample gas enters only by diffusion, minimizing the effect of sample-flow variations. In addition, the entire cell-block assembly is maintained at a constant optimum temperature through two heaters and a control thermistor which are located in the cell-block assembly.

The Sensing Unit's ELECTRONICS ASSEMBLY incorporates some of the solid-state electrical circuits. These circuits include:

Current Regulator — which supplies the constant current to the thermistor cell bridge circuit.

Proportional Action Temperature Controller — which maintains the entire cell block at a constant temperature.

Voltage to Current Converter/Amplifier — whose current output is transmitted to the analyzer's Control Unit.

Control Unit

The Control Unit houses the remaining measuring and power-supply circuits in an extruded aluminum DIN standard case. In addition the Control Unit contains the front-panel calibration adjustments for the analyzer system. These include the zero and span adjusters, and a span adjuster for the optional readout meter. A front-panel switch permits manually transferring the input to the Unit from sample gas to calibrating gas for easy calibration. Test points for the Control Unit's output circuits are also provided.

Integral Readout Meter on the Control Unit: This meter, mounted on the front panel of the control unit, provides a continuous readout indication of the gas under analysis on a 0-100 uniform scale (calibration curve supplied with the instrument).

Single or Dual Alarms: A single alarm (Hi or Lo) or dual alarms (one Hi one Low, two Hi, or two Lo) can be provided. The alarm consists of a digital thumbwheel set-point setter for each alarm level, an indicating lamp which is lit when an alarm is detected, and a relay output that can be used to actuate an external annunciator or to start a process shutdown device.

Performance Specifications

Accuracy: ±2% of span (output signal) at reference conditions for binary gas mixtures.

Linearity: Within ±2% of span for most standard ranges. If linearity exceeds ±2% a correction curve is supplied with the analyzer.

Meter: Accuracy: ±2% of span. Deadband: Less than 0.5% of span. Scale Length: 2-9/32″ (58.5 mm).

Repeatability: Short Term: ±0.3% of span.

Reproducibility: 24 Hour: ±1% of span.

Response Time: Maximum, for 4 cfh (2000 cc/min.) flow: For H_2: Initial, less than 1 second; 63%: 13 seconds; 90%: 23 seconds; 99%, 40 seconds. For CO_2 or SO_2: Initial, less than 2 seconds; 63%: 24 seconds; 90%: 45 seconds; 99%: 80 seconds.

Max. Drift: Zero: ±2% of span per week. Span: ±1% of span per week.

Ambient Temperature Influence: At Sensing Unit: Depends on range; typically less than 1% F.S. over entire temperature range. At Control Unit: ±0.005% of span per °F (±0.01% per °C).

Atmospheric Pressure Influence: ±0.1% of span per inch water (±0.05% per mm Hg).

Sample Flow Rate Influence: Less than 0.5% of span over flow range of 0.2 to 4 cfh (100 to 2000 cc/min.)

Line Voltage Influence: Max. 0.02% of span for each 1% change of line voltage.

Operating Specifications

Measuring Range: One or two ranges, as specified. For standard ranges, see Suffix D, in "Ordering Information". Where two ranges are specified, they must be zero-based, same type of gas (except for 507 and 508, dual range).

Output Ranges:
0-20 mA into 0-500 ohm load
4-20 mA into 0-500 ohm load
0-10 mV across 5000-ohm minimum load
0-100 mV across 50,000-ohm minimum load
0-1 V across 120,000-ohm minimum load
0-10 V across 2000-ohm minimum load

Alarm Circuits:
Set Point Resolution: 1%
Contact Ratings: 3 amps at 120 V a-c (resistive) or 3 amps at 28 V d-c (resistive) failsafe design, SPDT

Sample Requirements:
Sample Flow: 0.2 to 4.2 cfh (100 cc/min. to 2000 cc/min.)
Sample Pressure: 20″ H_2O (37 mm Hg), minimum (with filter and flow meter).

Reference Gas Requirements:
None required, except for ranges 080, 095, 098, 506, 507, 508, 510, 512 and 516; these require pure hydrogen reference gas flow, 0.02-0.2 cfh (10-100 cc/min.). Ranges 103, 601 and 703 require flowing air as the reference gas.

Ambient Requirements:
Relative Humidity: 90% maximum
Temperature Range: 14 F to 122 F (−10 C to +50 C)
Storage Temperature: 158 F (70 C maximum)

Power Requirements: (Control Unit Only)
117±10 V or 230±20 V, 50/60 Hz, 30 Watts.

Materials Contacting Sample Gas:
Sample contacts 316 stainless steel, Buna N, Teflon, glass and Viton.

Physical Specifications:
Sensing Unit:
  Weight: General Purpose—15 lb (7 kg). Explosion Proof—18¾ lb (8.5 kg)
  Dimensions: General Purpose—Approx. 6″ × 6″ × 11½″ (150 × 150 × 290 mm). Explosion Proof—Approx. 6″ × 6″ × 12¾″ (150 × 150 × 325 mm).
  Finish: Gray textured enamel
Control Unit (DIN standard case):
  Weight: 6½ lb (3 kg)
  Dimensions: 2⅞″ × 5⅝″ × 15″ (72 × 144 mm × 385 mm)
  Finish: Gray textured enamel (bezel), black enamel (front plate), extruded aluminum case

Connections:
Sample Inlet and Outlet: ¼″ OD tubing (compression fittings supplied)
Reference Gas Inlet and Outlet: ¼″ OD tubing (compression fittings supplied)
Electrical Power Inlet: Opening for ½″ Conduit (control unit only)
Sensing Unit Power Inlet (24V d-c from control unit): ½″ NPT (female conduit)

Miscellaneous:
General Purpose Sensing Unit: NEMA 4 (water-tight and dust-tight.)
Explosion-Proof Sensing Unit: Designed to meet NEMA 7, Class I, Division 1, Groups A, B, C and D.
Control Unit: NEMA 1 (general-purpose indoor).
Analyzer Temperature: Sensing Unit thermostated at 122 F (50 C).

Ordering Information

Catalog Numbering System:

A B C D E F G H L M

7866-☐-☐-☐-☐☐☐-☐-☐-☐-☐☐-☐-☐☐☐-☐☐☐

Suffix A—Line Voltage:
2 230 V 50/60 Hz
4 117 V 50/60 Hz

Suffix B—Output Signal:
1 0-20 mA
2 4-20 mA
3 0-10 V
4 0-1 V
5 0-100 V
6 0-10 mA

Suffix C — Stream Composition
1 H_2 in Air, N_2, O_2, Blast-Furnace Top Gas or Nitriding Atmospheres
2 CO_2 in Flue Gas, Air, N_2, O_2, or CH_4 (Specify)
4 O_2 in Dry H_2 (Oxygen Purity)
5 Helium in Air
6 Methane in Air, H_2

Suffix D — Range

001	0-1%	H_2 Only
002	0-2%	
005	0-5%	
010	0-10%	H_2 or CO_2 in Air, N_2 or O_2
015	0-15%	
020	0-20%	
030	0-30%	
518	0-40%	
519	0-100%	
050	20-50%	H_2 in Air, N_2 or O_2
514	45-55%	
075	0-75%*	
080	0-80%	
548	40-80%	
515	60-80%	
503	0-100%	
516	85-100%	
506	90-100%	
095	95-100%	
098	98-100%	
103	50-100%	
501	50-100% H_2 in CH_4	
111	0-100% H_2 in CO_2	
517	5-15% Methane in Air	
512	0-30% Methane in H_2	
090	95-100% O_2 (Balance H_2)	
510	70-100% Helium in Air	

*Dissociated ammonia

703 Triple Range for Hydrogen Cooled Generator-Application 0-100% CO_2 in air; 0-100% CO_2 in H_2; 100-75% H_2 in air. Uses 4-port flowing reference; reference gas is air. Specify complete catalog #7866-☐-☐-1-703-1-2-7-05-2-☐☐☐ for new installation. Includes Sensing Unit and Control Unit, and two SPST alarm contacts. Specify appropriate suffix for A&B. Suffix M must be 206, 208 or 239.

992 Dual Ranges (For 100-98% and 100-90% H_2 in Air, N_2 or O_2, Insert Range Numbers 507 and 508 as Suffix M)

Suffix E—Integral Meter on Control Unit:
1 Meter Included, With 0-100 Uniform Scale

Suffix F—Control Unit:
2 Complete Control Unit Assembly

Suffix G—Sensing Unit:
1 With General-Purpose Housing
3 With Explosion-Proof Housing
7 With Explosion-Proof Housing, for Ranges Requiring Flowing Reference Gas (080, 095, 098, 103, 506, 510, 512, 516, 601 or 703)

Suffix H—Alarms:
01 One Low Alarm (Suffix L must be "0")
02 One High Alarm (Suffix L must be "0")
03 One High, One Low Alarm
04 Two Low Alarms
05 Two High Alarms

Suffix L—Alarm Connections at Terminal Board
0 Standard: 2 SPDT, Non-Isolated
1 One SPDT and one SPST (NC), Isolated
2 One SPDT and one SPST (NO), Isolated

Suffix M—Optional Features (Omit suffix if not required)
206 Linen Tags (15 characters max. on each of three lines: specify legend). One mounted on Control Unit, one on Sensing Unit.
208 Stainless Steel Tags (22 characters max. on each of three lines: specify legend) One Mounted on Control Unit, one on Sensing Unit.
239 Engraved Nameplate (20 characters max. on each of two lines: specify legend) mounted on front face of Control Unit.
155 Solenoid valve for remote switching to calibrating gas.

☐☐☐ ☐☐☐ Range Suffixes; two are specified when "992" is specified for Suffix D, to provide a dual range. Both ranges must use the same zero gas for calibration.

Sampling Systems:

Prepackaged sampling systems appropriate to the application are available; contact your local L&N office for details.

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Instrument & System Solutions!

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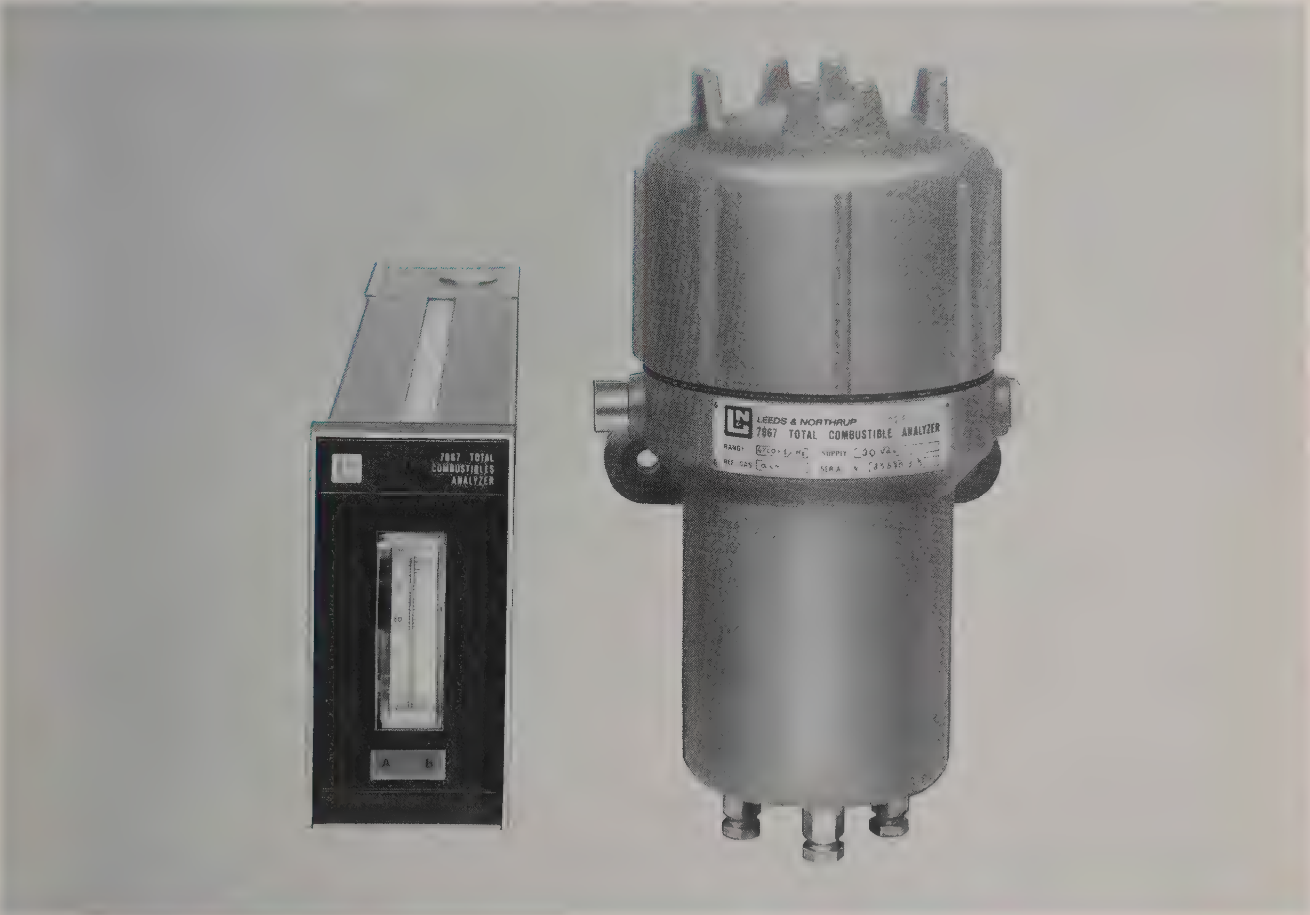
C3.1131-DS

Another Member of L&N's Family of Gas Analyzers

7867 Total Combustibles Analyzer


7867 TOTAL
COMBUSTIBLES
ANALYZER
LEEDS & NORTHRUP
7867 TOTAL COMBUSTIBLE ANALYZER

- High speed of response
- High sensitivity
- Excellent stability
- Reliable solid state design
- Lower installation costs through optional remote mounting capability of the Sensing Unit (Transmitter)
- General-purpose NEMA 4 housing of the Sensing Unit
- Signal transmission from the Sensing Unit up to 1000 feet over unshielded leadwires
- Standard 30 V d-c supply voltage to the field-mounted Sensing Unit
- Control Unit indicating meter
- Voltage or current output signals from the Control Unit
- Single or optional dual alarms with digital thumbwheel setters
- Panel-mounted Control Unit (Receiver)

LEEDS & NORTHRUP
A UNIT OF GENERAL SIGNAL

We put you in control.

7867 Total Combustibles Analyzer

Field-Mount the Transmitter up to 1000 Feet from the Control Unit

The Leeds & Northrup Catalog 7867 Total Combustibles Analyzer is designed to provide a highly sensitive, accurate, and continuous analysis of flue gases and other oxygen-deficient gases to determine the total concentration of combustible gases in a sample stream.

The Total Combustibles Analyzer's measurement is based on the unbalance of a Wheatstone-bridge circuit, resulting from the heat produced from the oxidation of the measured gases through catalytic combustion. A flow of combustion air is passed through the Sensing Unit and combustion takes place on a catalytically-coated measuring filament which is an active arm of the bridge circuit.

FLIP-DOWN DOOR, MAGNETICALLY LATCHED, FOR EASY ACCESSIBILITY
CHASSIS SLIDES OUT OF CASE FOR ROUTINE MAINTENANCE WHEN REQUIRED.

Measurement Method

The concentration of combustible gases in the sample stream is converted to an electrical signal through the oxidation of these gases and the measurement of the heat produced. The combustion takes place on the surface of a measuring filament, coated with a catalyst which permits controlled combustion to occur at lower-than-ignition temperatures. This measuring filament forms one arm of a Wheatstone-bridge circuit; the other active arm of the bridge circuit is the reference filament, identical to the measuring filament except that it is not coated. Both filaments are exposed to the same sample stream, to which dilution air has been previously added in a mixing chamber. Both filaments (the two active arms of the bridge circuit) are therefore influenced identically by temperature, pressure, flow and background-gas variation in the cell assembly. Only the combustion of the sample stream's combustible gases at the measuring filament, and the resulting temperature change in this arm of the bridge circuit, will affect the balance of the bridge and thus provide an output signal. This signal is proportional to the concentration of the total combustibles in the sample stream.

The Analyzer consists of two basic components — the Sensing Unit (Transmitter) and the Control Unit (Receiver).

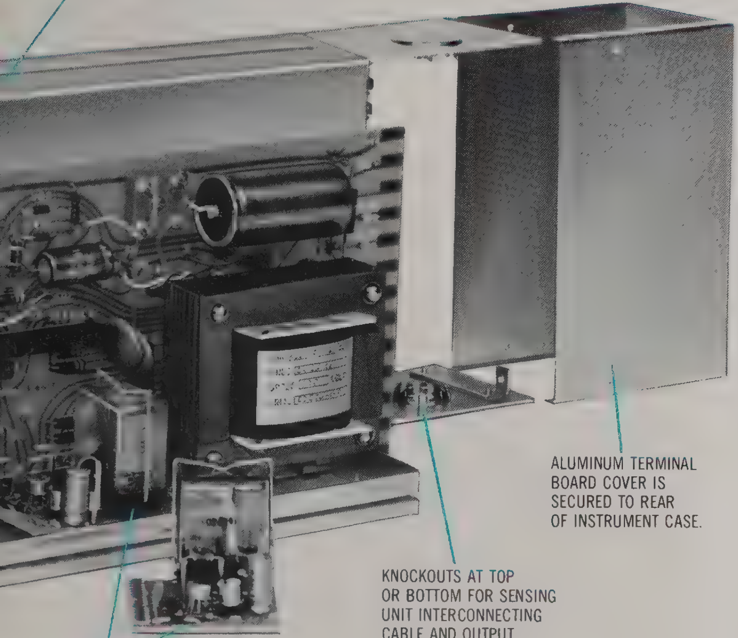
The Sensing Unit receives a continuous flow of combustion air, measures the concentration of combustible gas, and transmits an electrical signal to the Control Unit. The Sensing Unit is ruggedly constructed to meet most environmental conditions, and is designed to be mounted up to 1,000 feet from the Control Unit with only a single, four-conductor non-shielded cable connecting the two, resulting in greater flexibility and lower installation costs

The Control Unit receives the output signal from the Sensing Unit at the sampling site by way of the interconnecting cable. The same cable supplies the operating voltage (30 V d-c) to the Sensing Unit from the Control Unit.

The Control Unit is designed for simplified panel-mounting either at the sampling site, if environmental conditions permit, or in a control room. The Unit can provide a voltage or current output signal to an auxiliary instrument such as a strip-chart recorder, and is equipped with an indicating meter for direct readout and monitoring of the combustible gas concentration. The Control Unit can also be supplied with one or two alarms with digital thumbwheel setpoint setters. When an alarm is detected, a relay contact is energized to activate an external annunciator or auxiliary relay to initiate a shut-down procedure for the process. The relay is inherently failsafe since it is normally energized and provides a contact closure on loss of power.

The 7867 Total Combustibles Analyzer can be used in facilities where protection of plant and personnel is essential due to the presence of combustible gases and flammable liquids. Some of the typical applications are:

INDUSTRY	APPLICATION
Electric Power	Utility tunnels, power cable vaults, hydrogen cooled generators
Chemical	Flue gas monitoring, distilling operations
Petroleum	Pipeline pumping stations; gasoline blending, storage and handling; crude oil facilities.
Primary Metals	Controlled atmosphere furnaces, metal finishing facilities.

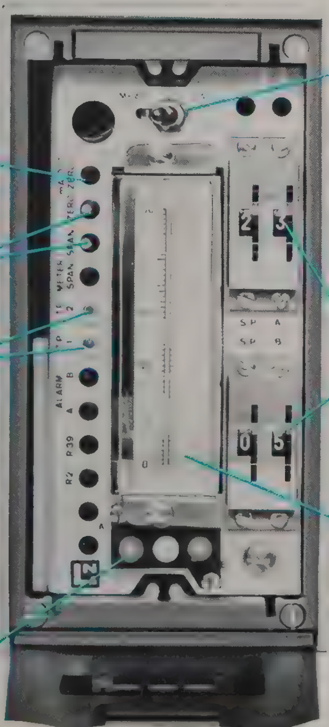


EXTRUDED ALUMINUM CASE
DESIGNED FOR EASY PANEL MOUNTING.

ALUMINUM TERMINAL
BOARD COVER IS
SECURED TO REAR
OF INSTRUMENT CASE.

KNOCKOUTS AT TOP
OR BOTTOM FOR SENSING
UNIT INTERCONNECTING
CABLE AND OUTPUT
SIGNAL CONDUCTORS.

ALARM OUTPUT
RELAYS WITH
FAILSAFE FEATURES.



CURRENT-OUTPUT
ADJUSTMENT

ZERO AND SPAN
ADJUSTMENTS FOR
EASY CALIBRATION

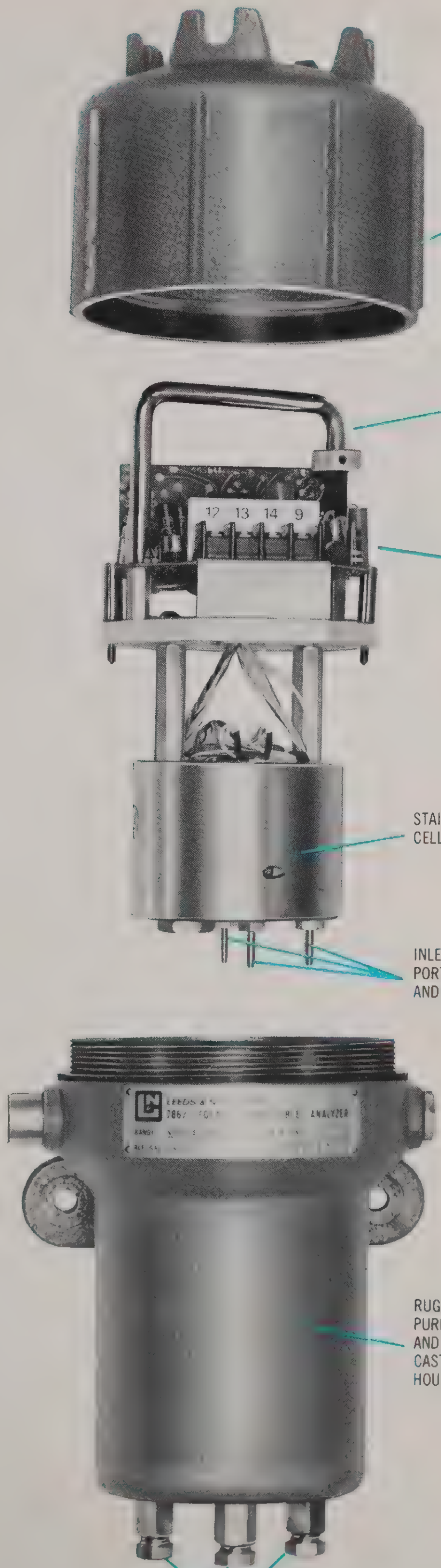
OUTPUT-CIRCUIT
TEST POINTS

ALARM
NDICATION LAMPS

"MEASURE/CALIBRATE"
SWITCH FOR INPUT
GAS SELECTION

DIGITAL ALARM
SET-POINT SETTERS

INDICATING METER
FOR READOUT
IN PERCENT
CONCENTRATION



RUGGED THREADED
CAP SEATS ON
GASKETED HOUSING.

STAINLESS-STEEL
HANDLE FACILITATES
REMOVAL OF
SENSOR ASSEMBLY.

CELL-BLOCK
ELECTRONICS
ASSEMBLY.

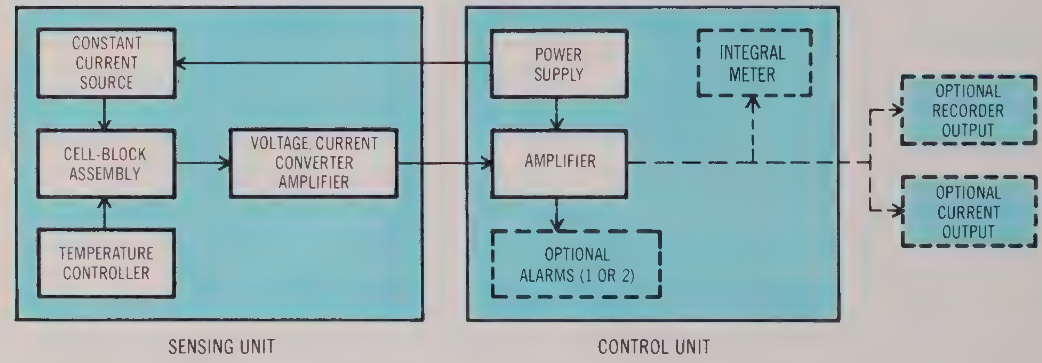
STAINLESS-STEEL
CELL-BLOCK ASSEMBLY.

INLET AND OUTLET
PORTS TO MEASURING
AND REFERENCE CELLS.

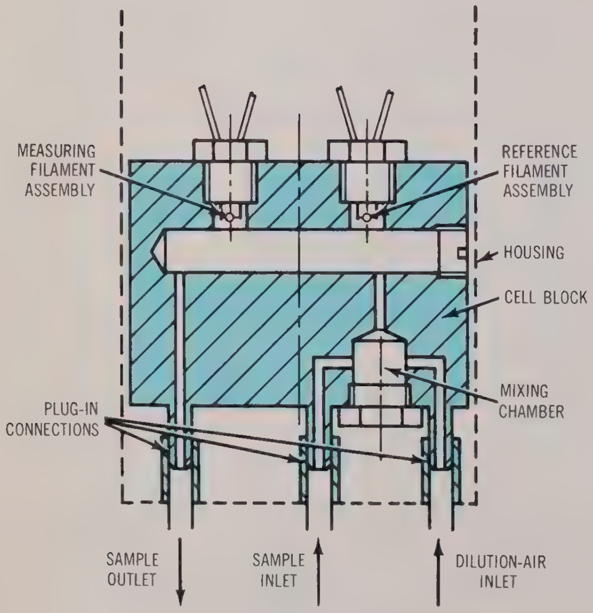
RUGGED, GENERAL-
PURPOSE WATERPROOF
AND DUST PROOF
CAST-ALUMINUM
HOUSING.

INLET AND OUTLET PORTS FOR SAMPLE GAS

Reliable Solid State Circuit Design Plus Simplified Modular Construction Add Up to Minimum Downtime and Easy Routine Maintenance.


CONSTANT CURRENT SOURCE
CELL-BLOCK ASSEMBLY
TEMPERATURE CONTROLLER
VOLTAGE, CURRENT CONVERTER AMPLIFIER
POWER SUPPLY
INTEGRAL METER
AMPLIFIER
OPTIONAL ALARMS (1 OR 2)
OPTIONAL RECORDER OUTPUT
OPTIONAL CURRENT OUTPUT
SENSING UNIT
CONTROL UNIT

Block Diagram of 7867 Total Combustibles Analyzer


MEASURING FILAMENT ASSEMBLY
REFERENCE FILAMENT ASSEMBLY
HOUSING
CELL BLOCK
MIXING CHAMBER
PLUG-IN CONNECTIONS
SAMPLE OUTLET
SAMPLE INLET
DILUTION-AIR INLET

Cross-Section of Sensing Unit

Sensing Unit

The 7867 Total Combustibles Analyzer's Sensor Assembly can be supplied in either a general-purpose or explosion-proof housing. Both types of housing are of rugged cast-aluminum construction which permits reliable operation under adverse ambient conditions.

The Sensor Assembly comprises two sections — the cell-block assembly and the electronics assembly.

The CELL BLOCK ASSEMBLY is of stainless-steel construction with two identical internal cells: the measuring cell and the reference cell. A highly stable pelletized platinum filament is mounted in each cell. These filaments are the active arms of the bridge circuit. Enough air is admitted to the cell-block assembly to insure complete combustion.

The cells in which the filaments are mounted are dead-ended so the sample gas enters only by diffusion, minimizing the effect of sample-flow variations. In addition, the entire cell-block assembly is maintained at a constant optimum temperature through two heaters and a control thermistor which are located in the cell-block assembly.

Control Unit

The Control Unit houses the remaining measuring and power-supply circuits in an extruded aluminum DIN standard case. In addition the Control Unit contains the front-panel calibration adjustments for the analyzer system. These include the zero and span adjusters, and a span adjuster for the readout meter. A front-panel switch permits manually transferring the input to the Unit from sample gas to calibrating air (zero combustibles) for easy calibration. Test points for the Control Unit's output circuits are also provided.

Integral Readout Meter on the Control Unit: This meter, mounted on the front panel of the control unit, provides a continuous readout indication, in percent concentration, of total combustibles.

Single or Dual Alarms: A single alarm (Hi or Lo) or dual alarms (one Hi one Lo, two Hi, or two Lo) can be provided. The alarm consists of a digital thumbwheel set-point setter for each alarm level, an indicating lamp which is lit when an alarm is detected, and a relay output that can be used to actuate an external annunciator or to start a process shutdown device.

Performance Specifications

Accuracy: ±4% of span (output signal).

Linearity: Within ±3% of span for standard ranges.

Meter: Accuracy: ±2.5% of span. Deadband: Less than 0.5% of span. Scale Length: 2-9/32" (58.5 mm).

Repeatability: Short Term: ±0.5% of span.

Reproducibility: 24 Hours: ±1% of span.

Response Time: Maximum for 2.1 cfh (1000 cc/min.) flow: Initial, less than one second; to 90% of step-change, 10 seconds.

Drift: Zero: ±2% of span per week, maximum. Span: ±1% of span per week, maximum.

Ambient Temperature Influence: At Sensing Unit: Depends on range. Less than 1% F.S. over entire temperature range. Control Unit, ±0.005% of span per °F (±0.01% of span per °C).

Atmospheric Pressure Influence: ±0.037% of span per inch H_2O (±0.02% of span per mm Hg).

Sample Flow-Rate Influence: Ratio of sample flow rate to air flow rate must be constant.

Line Voltage Influence: 0.05% of span, maximum, for each 1% change in voltage.

Operating Specifications

Measuring Range (one range, as specified):
0-5% Combustibles 0-10% Combustibles 0-100% LEL/LFL

Output (Non-isolated):
0-20 mA into 0-500 ohm load
4-20 mA into 0-500 ohm load
0-10 mV across 5000-ohm minimum load
0-100 mV across 50,000-ohm minimum load
0-1 V across 120,000-ohm minimum load
0-10 V across 2000-ohm minimum load

Alarm Circuits:
Set Point Resolution: 1% of span
Contact Ratings: 3 amps at 120 V a-c (resistive) or 28 V d-c (resistive); SPDT, failsafe design

Sample Requirements:
Total Flow (Sample plus Dilution Air): 1.0 to 4.2 cfh (1000 to 2000 cc/min)
Sample Flow: 0-5% range, 2.1 cfh (1000 cc/min); 0-10% range, 1.05 cfh (500 cc/min)
Dilution-Air Flow: 0-5% range, 2.1 cfh (1000 cc/min); 0-10% range, 3.15 cfh (1500 cc/min)
Sample Pressure: 20" H_2O (37 mm Hg), minimum (with filter and flow meter)

Ambient Requirements:
Relative Humidity: 90% maximum
Temperature Range: 14 F to 122 F (−10 C to +50 C)
Storage Temperature: 158 F (70 C maximum)

Material Contacting Sample Gas:
Sample contacts 316, 304 and 303 stainless steel, platinum, alumina, Buna N and Viton.

Power Requirements: (Control Unit Only)
Line Voltage: 117 V ±10 V or 230 V ±20 V, 50/60 Hz, 30 Watts

Physical Specifications:
Sensing Unit:
  Weight: General Purpose — 15 lb (7 kg). Explosion Proof — 18¾ lb (8.5 kg).
  Dimensions: General Purpose — Approx. 6" x 6" x 11½" (150 x 150 x 290 mm). Explosion Proof — Approx. 6" x 6" x 12¾" (150 x 150 x 325 mm).
  Finish: Gray textured enamel
Control Unit (DIN standard case):
  Weight: 6½ lb (3 kg)
  Dimensions: 2⅞" x 5⅝" x 15" (72 x 144 mm x 385 mm)
  Finish: Gray textured enamel (bezel), black enamel (front plate), extruded aluminum case

Connections:
Sample Inlet and Outlet: ¼" OD tubing (compression fittings supplied)
Dilution Air Inlet: ¼" OD tubing (compression fittings supplied).
Electrical Power Inlet: Opening for ½" Conduit (control unit only)
Sensing Unit Power Inlet (30 V d-c from control unit): ½" NPT (female Conduit)

Miscellaneous:

General-Purpose Sensing Unit: NEMA 4 (water-tight and dust-tight.)

Control Unit: NEMA 1 (general-purpose indoor)
Analyzer Temperature: Sensing Unit thermostated at 122 F (50 C)

Ordering Information

Catalog Numbering System:

```
         A B C   D    EFG  H   L     M
7867 -□-□-1-□□□-1-2-□-□□-□-□□□-□□□
```

Suffix A — Line Voltage:
2 230 V 50/60 Hz
4 115 V 50/60 Hz

Suffix B — Output Signal:
0 Used when Suffix F is "0"
1 0-20 mA
2 4-20 mA
3 0-10 V
4 0-1 V
5 0-100 mV
6 0-10 mV

Suffix C — Stream Composition:
1 For Combustion Processes

Suffix D — Range:
005 0-5% Combustibles, Calibrated as CO in N_2, or 0-2.5% Combustibles, Calibrated as CH_4 in N_2, or 0-1.5% Combustibles, Calibrated as H_2 in N_2
010 0-10% Combustibles, Calibrated as CO in N_2, or 0-5% Combustibles, Calibrated as CH_4 in N_2, or 0-3% Combustibles, Calibrated as H_2 in N_2

Suffix E — Integral Meter on Control Unit:
1 Meter Included

Suffix F — Control Unit:
2 Complete Control Unit Assembly

Suffix G — Sensing Unit:
1 With General-Purpose Housing
3 With Explosion-Proof Housing

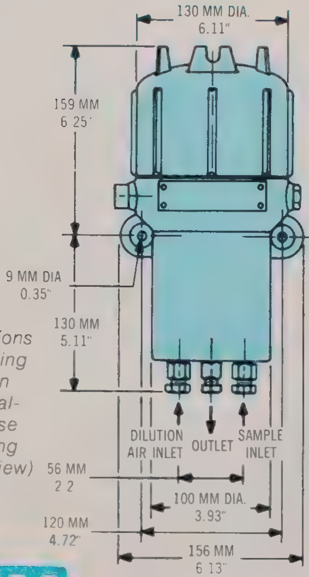
Suffix H — Alarms:
01 One Low Alarm (Suffix L must be "0")
02 One High Alarm (Suffix L must be "0")
03 One High, One Low Alarm
04 Two Low Alarms
05 Two High Alarms

Suffix L — Alarm Connections at Terminal Board
0 Standard: With One Alarm, 1 SPDT; With Two Alarms, 2 SPDT, Non-Isolated
1 One SPDT and one SPST (NC), Isolated
2 One SPDT and one SPST (NO), Isolated

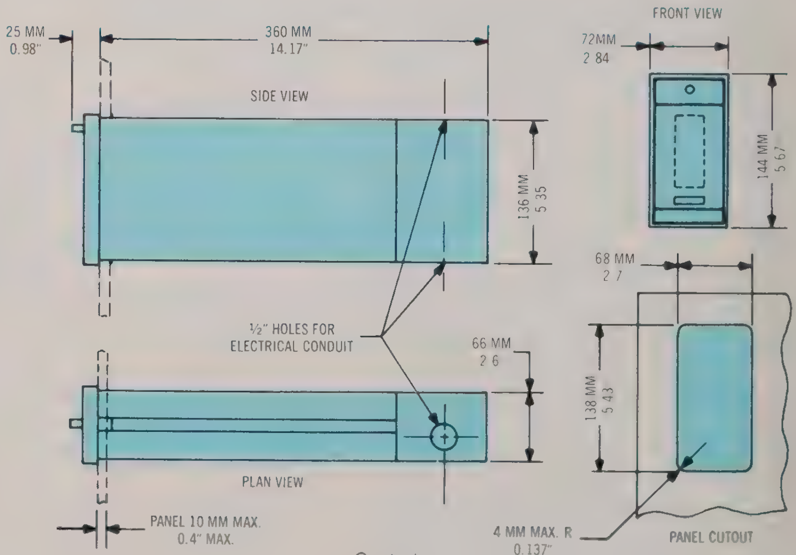
Suffix M — Optional Features (Omit suffix if not required)
206 Linen Tags (15 characters max. on each of three lines: specify legend). One mounted on Control Unit, one on Sensing Unit.
208 Stainless Steel Tags (22 characters max. on each of three lines: specify legend) One Mounted on Control Unit, one on Sensing Unit.
239 Engraved Nameplate (20 characters max. on each of two lines: specify legend) mounted on front face of Control Unit.
155 Solenoid Valve for remote switching to calibrating air (zero combustibles)

Sampling Systems:

Prepackaged 7872-Series Sampling Systems appropriate to the application are available; contact your local L&N office for details.


130 MM DIA.
6.11"
159 MM
6.25"
9 MM DIA
0.35"
130 MM
5.11"
DILUTION AIR INLET
OUTLET
SAMPLE INLET
56 MM
2.2
100 MM DIA.
3.93"
120 MM
4.72"
156 MM
6.13"

Dimensions of Sensing Unit in General-Purpose Housing (Front View)


25 MM
0.98"
360 MM
14.17"
SIDE VIEW
136 MM
5.35
½" HOLES FOR ELECTRICAL CONDUIT
66 MM
2.6
PLAN VIEW
PANEL 10 MM MAX.
0.4" MAX.
4 MM MAX. R
0.137"
FRONT VIEW
72MM
2.84
144 MM
5.67
68 MM
2.7
138 MM
5.43
PANEL CUTOUT

Control Unit Dimensions

LEEDS & NORTHRUP North Wales, PA 19454
A UNIT OF GENERAL SIGNAL

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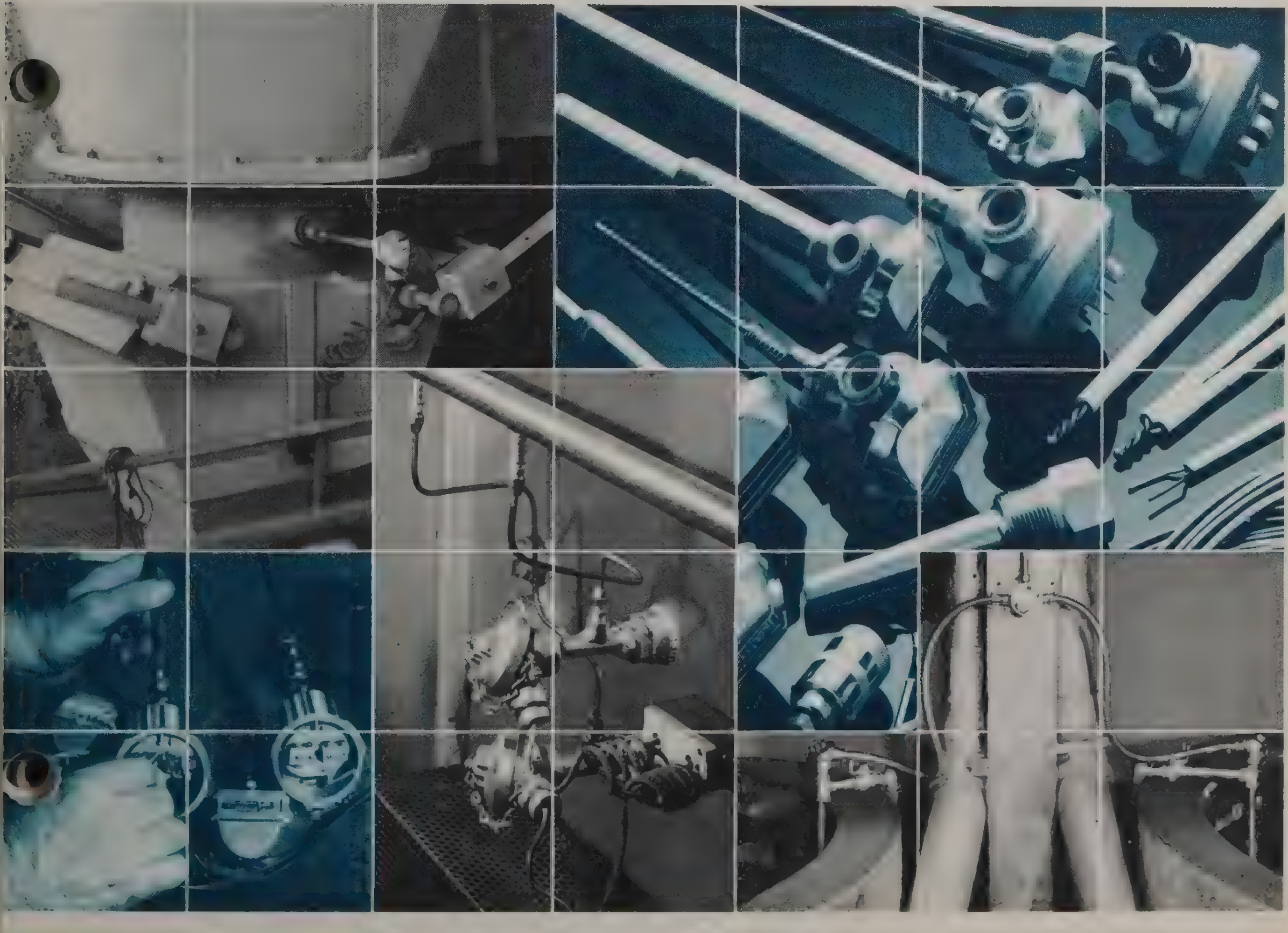
Leeds & Northrup Instruments

Temperature Sensors

Assemblies • Parts • Accessories



Leeds & Northrup Instruments
Temperature Sensors
Assemblies · Parts · Accessories

Temperature sensor reliability is a key factor in the dependable measurement expected by users of pyrometers, temperature indicators, recorders and controllers. For this reason temperature sensors and assemblies, with their components, are not regarded by L&N as mere accessories, but as precise elements to which we continually devote research, engineering, manufacturing and testing skills, as attentively as to the measuring instruments themselves.

We offer a comprehensive line of assembled sensors and extension leadwires for all usual applications. In addition, we carry a large supply of standardized temperature sensing wire in a wide range of sizes, and parts such as insulators, connectors, terminal heads, protection tubes and thermowells, and flanges and bushings.

Special temperature sensors can be supplied to meet many unusual requirements. . . and since our stock of standardized wire and many standard parts can be utilized, special sensors often cost little more than standard ones. Since the proper choice of a temperature sensor for a specific application is of equal importance to sensor quality, we also offer in this catalog information which should be generally useful as a guide to the correct choice of temperature sensing material and protection tube or thermowell.

If you have a specific problem requiring additional information, simply call our local Field Office. An experienced engineer will give it careful attention.

Leeds & Northrup Instruments
. . . We put you in control

Leeds & Northrup Instruments

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Selection of Elements

The thermocouple combinations most commonly used bear Instrument Society of America (ISA) letter designations.

The base-metal thermocouples are:

Type J	Iron-Constantan
Type K	Nickel, Chromium-Nickel, Aluminum
Type T	Copper-Constantan
Type E	Nickel, Chromium-Constantan
Type N*	Nicrosil-Nisil

The noble-metal thermocouples are:

Type S	Platinum, 10% Rhodium-Platinum
Type R	Platinum, 13% Rhodium-Platinum
Type B	Platinum, 30% Rhodium-Platinum, 6% Rhodium

The following tables provide a description of the characteristics of these thermocouples and a few precautions to be observed in their use.

COMPARISON OF THERMOCOUPLE TYPES

Type	Usable Temperature Range	Advantages	Restrictions
Type J (Iron-Constantan)	−300 to 1400 F	1. Comparatively inexpensive. 2. Suitable for continuous service to 1400 F in neutral or reducing atmospheres.	1. Maximum upper limit in oxidizing atmosphere is 1400 F, due to the oxidization of the iron. 2. Protection tubes should be used above 900 F. 3. Protection tubes should always be used in a contaminating medium.
Type K* (Nickel, Chromium-Nickel, Aluminum)	32 F to 2300 F	1. Suitable for oxidizing atmospheres. 2. In higher temperature ranges, provides a more mechanically- and thermally-rugged unit than platinum, rhodium-platinum, and longer life than iron-constantan.	1. Especially vulnerable to reducing atmospheres, requiring substantial protection when used. 2. Should not be used in sulfurous atmospheres unless properly protected.
Type T (Copper-Constantan)	−300 F to 700 F	1. Resists atmosphere corrosion. 2. Applicable in reducing or oxidizing atmospheres below 600 F. 3. Its stability makes it useful at sub-zero temperatures. 4. Has high conformity to published calibration data.	1. Copper oxidizes above 600 F.
Type E (Nickel, Chromium-Constantan)	−300 F to 1600 F	1. Has high thermoelectric power. 2. Both elements are highly corrosion-resistant, permitting use in oxidizing atmospheres. 3. Does not corrode at sub-zero temperatures.	1. Stability is unsatisfactory in reducing atmospheres.
Type N (Nicrosil-Nisil)	32 F to 2300 F	1. Superior thermal stability compared to Type K. 2. Longer life, better accuracy for longer periods than Type K 3. More resistant to "green rot" corrosion.	1. Should not be used in reducing or sulfurous atmospheres unless properly protected.
Type S (Platinum, 10% Rhodium-Platinum)	0 F to 2700 F	1. Usable in oxidizing atmospheres. 2. Provides a higher usable range than Type K. 3. Frequently more practical than non-contact pyrometers. 4. Has high conformity to published calibration data	1. Easily contaminated in other than oxidizing atmospheres.
Type R (Platinum, 13% (Rhodium-Platinum)			
Type B (Platinum, 30% Rhodium-Platinum, 6% Rhodium)	1600 F to 3100 F	1. Better stability than Type S or R. 2. Increased mechanical strength. 3. Usable to higher temperatures than Type S or R. 4. Reference-junction compensation is not required if junction temperature does not exceed 150 F.	1. Available in standard grade only. 2. High temperature limit requires the use of alumina insulators and protection tubes. 3. Easily contaminated in other than oxidizing atmospheres.

TEMPERATURE LIMITS IN OXIDIZING ATMOSPHERES*

Thermocouple			AWG					
Type	Material	Condition	8	14	16	20	24	30
Type J	Iron-Constantan	Bare Protected	1200 F 1400 F	900 F 1100 F	900 F 1100 F	800 F 900 F	650 F 700 F	600 F 700 F
Type K	Nickel, Chromium-Nickel, Aluminum	Bare Protected	2000 F 2300 F	1700 F 2000 F	1700 F 2000 F	1600 F 1800 F	1400 F 1600 F	1300 F 1500 F
Type N	Nicrosil-Nisil							
Type T	Copper-Constantan	Bare Protected	— —	600 F 700 F	500 F 600 F	400 F 500 F	400 F 400 F	400 F 400 F
Type E	Nickel, Chromium-Constantan	Bare Protected	1400 F 1600 F	1100 F 1200 F	1100 F 1200 F	900 F 1000 F	700 F 800 F	700 F 800 F
Type S and R	Platinum, Rhodium-Platinum	Protected	—	—	—	2800 F	2700 F	2400 F
Type B	Platinum, 30% Rhodium-Platinum, 6% Rhodium	Protected	—	—	—	—	3100 F	—

*Designation approved by ISA as of November 15, 1983

**Upper temperature limits are a function of wire diameter; since temperature tends to have deleterious effects on thermocouples, the larger the amount of the material in the thermocouple cross-section, the longer it can be expected to last

Thermocouple Accuracy

Stock Thermocouples and Wires

All wires forming L&N thermocouples, and all L&N wires supplied to be used together as thermocouples, are standardized and matched to perform in accordance with established millivolt/temperature characteristics within the *standard limits of error* shown below. (These are in accordance with ANSI as published in MC96.1-1982). Wires and thermocouples assemblies meeting the special limits of error can be supplied when specified.

LIMITS OF ERROR

ANSI Type	Type of Thermocouple	IPTS	Temperature Range	Limits of Error*	
				Standard	Special
J	Iron and Constantan	68**	−310 to −100 F	—	±2%
			−100 to +600 F	±4 F	±2 F
			600 to 800 F	±4 F	±⅓%
			800 to 1400 F	±¾%	±⅓%
K	Nickel, Chromium and Nickel, Aluminum	68**	32 to 530 F	±4 F	±2 F
			530 to 2300 F	±¾%	±⅜%
T	Copper and Constantan	68**	−300 to −75 F	—	±1%
			−150 to −75 F	±2%	±1%
			−75 to +200 F	±1½ F	±¾ F
			200 to 700 F	±¾%	±⅜%
E	Nickel, Chromium and Constantan	68**	32 to 600 F	±3 F	±2 F
			600 to 1600 F	±½%	±⅜%
N	Nicrosil and Nisil	68	32 to 530 F	±4 F	
			530 to 2300 F	±¾%	
S	Platinum, 10% Rhodium and Platinum	68	0 to 1000 F	±2.5 F	±1.5 F†
			1000 to 2700 F	±0.25%	±0.15%†
		48	0 to 1000 F	±5 F††	±2.5 F
			1000 to 2700 F	±0.5%††	±0.25%
R	Platinum, 13% Rhodium and Platinum	68	0 to 1000 F	±2.5 F	—
			1000 to 2700 F	±0.25%	—
		48	0 to 1000 F	±5 F††	±2.5 F
			1000 to 2700 F	±0.5%††	±0.25%
B	Platinum, 30% Rhodium and Platinum, 6% Rhodium	68	1600 to 3100 F	±½%	—

**When expressed as a percentage, the limit of error is a percentage of the temperature reading, not of the range*

***L&N wires, elements, etc. listed for these base-metal thermocouples can be used with instruments having scales calibrated to match either IPTS-68 or IPTS-48*

†These limits of error apply only to the 24 AWG platinum wire (24-1-6) and the 24 AWG platinum, 10% rhodium wire (24-1-63)

††These limits of error apply only to the 24 AWG platinum wire (24-1-29), 24 AWG platinum, 10% rhodium wire (24-1-30) and the 24 AWG platinum, 13% rhodium wire (24-1-56)

Millivolt/temperature characteristics for IPTS 48 are tabulated in "Conversion Tables for Thermocouples", 077989. Taken from NBS Circular 561, the tables are based upon absolute units of emf and the International Practical Temperature Scale of 1948. Millivolt/temperature characteristics for IPTS 68 are tabulated in "Temperature-EMF Tables for Thermocouples Referenced to IPTS 68", 177610. Taken from NBS Monograph 125, the tables are based on absolute units of emf and the International Practical Temperature Scale of 1968.

Checked Thermocouples and Wires

When specified, thermocouples and wires for use as working standards, or for other uses where it is advantageous to know actual deviation from published millivolt/temperature characteristics, are given an additional check prior to shipment and are tagged with correction data at specified temperatures. (For checking, thermocouples must be 24 inches or longer.)

Thermocouples and wires thus checked are taken from stock or made to order, and do not necessarily have a smaller limit of error than untagged thermocouples or wires. However, their deviations from established values at temperatures specified by the user are known and can be taken into account.

The number of temperatures at which checks are made depends upon the temperature range-band over which the thermocouples are to operate. For base-metal thermocouples, checks can be made at any point between −100 and 2300 F, depending upon wire type, gauge and insulation. For noble-metal thermocouples, checks can be made between 33 and 3000 F.

Temperature Range Span	Check Points	Check Point Location
400 F or Less	1	High End of Span
800 F or Less	2	Mid-Range and High End
1200 F or Less	3	⅓, ⅔ and High End
1600 F or Less	4	¼, ½, ¾ and High End
2000 F or Less	5	⅕, ⅖, ⅗, ⅘ and High End

Accuracy of Tagged Check Data

For temperature checks up to 500F, the thermocouple or wire is tagged to 0.1 F, with an uncertainty of reading of 0.5 F; from 500 to 2000 F, tagged to 1.0 F, with an uncertainty of 2.0 F; and from 2000 to 2300 F, tagged to 1.0 F, with an uncertainty of 4.0 F. Similar checks can be made up to 260 C, with the thermocouple or wire tagged to 0.1 C with an uncertainty of 0.28 C; from 260 to 1093 C, tagged to 1.0 C with an uncertainty of 1.11 C; and from 1093 to 1260 C, tagged to 1.0 C with an uncertainty of 2.22 C.

Wire Samples

When pairs of wires are checked to be used together, at least two samples of both wires (one sample from each end of each reel or spool) are made into thermocouples and tested at specified temperatures. When only one wire is to be checked, thermocouples are made by combining each sample with a wire of the same material, whose thermal emf is known.

For wire lengths in excess of 1000 feet, additional samples are taken at intervals of approximately 1000 feet as a precaution against possible variations in thermoelectric characteristics of the wire along its length.

Platinum Thermocouples

Type S (platinum, 10% rhodium-platinum) elements and thermocouples with IPTS 68 calibration can be supplied with either an NBS Report of Calibration and Test, or an L&N Report of Calibration.

Selection of Protection Tubes and Thermowells

Practically all thermocouples used for industrial applications have a protection tube or thermowell, to provide adequate protection for the thermocouple element.

Protection tubes and wells serve the double purpose of guarding the thermocouple against mechanical damage, and interposing a shield between the thermocouple and its surroundings to avoid contamination and eventual failure, by maintaining it, as nearly as possible, in its best atmosphere.

Numerous factors affect the choice of tubes and thermowells. The most important of these include:

1. Operating and maximum temperatures
2. The chemical environment: oxidizing, reducing, corrosive or neutral
3. Adequate response time
4. Thermal and mechanical strength required
5. Pressure and flow velocity of the measured medium.

For recommendations of materials for specific applications, see pages 6 and 7.

Metal Protection Tubes

Metal protection tubes are used in atmospheres and liquids at ordinary pressures (atmospheric to 50 psig). When metal tubes are equipped with a pipe-thread bushing for mounting, they may be exposed to low or medium pressures; the maximum pressure depends upon the material and construction of the tube, and the temperature and rate of flow of the medium.

Depending upon the material, metal tubes can offer adequate mechanical protection for thermocouples at temperatures as high as 2100 F (1150 C). Since all metallic tubes are somewhat porous at temperatures exceeding 1500 F (815 C), it may be necessary in some cases to provide an inner (primary) tube of ceramic material.

Metal protecting tubes are usually supplied in one of the materials listed in the table on the next page. (Special materials, however can occasionally be supplied.) With the exception of cast iron, all of the materials listed are available with the closed end spun and welded. Solid bar stock of 28% chromium-iron (446 SS) or nickel is used for drilled tubes.

Metal-Ceramic Protection Tubes

Metal-ceramic ("Cermet") protection tubes are composed of a metal and a metallic oxide, such as LT-1. This has a chemical composition of 77% chromium and 23% aluminum oxide, and has a maximum operating temperature of 2500 F (1370 C). The tubes have excellent oxidation resistance, and resist wetting by many metals and alloys as well as by basic furnace slags. They are superior to ceramic tubes in thermal shock resistance and mechanical strength, but are less resistant to shock and impact than metallic alloys. When used in molten metal at 2000 F (1090 C) or higher, for example, a tube should be preheated to about 900 F (480 C) before insertion.

Typical applications include: copper-base alloys, to 2100 F (1150 C); blast-furnace and stack gases, to 2400 F (1315 C); sulfur burner gases, to 2000 F (1090 C); cement-kiln atmospheres, to 2200 F (1205 C); and chemical-process reactors, to 2500 F (1370 C).

The tubes are *not* recommended for use in carburizing or nitrogen atmospheres, nor in molten aluminum applications.

Ceramic Protection Tubes

Ceramic tubes are primarily used with noble-metal thermocouples at high temperatures, to protect the element from contaminating environments. (To prevent thermal shock, Fyrestan and high-purity alumina tubes should be preheated at the rate of 200° F per hour, up to 800 F.) They are also used with base-metal thermocouples at lower temperatures, in atmospheres harmful to metal tubes. Resistant to high temperatures, they are also chemically inert, and possess good abrasion resistance and high dielectric strength.

Principal applications in which ceramic tubes are *not* recommended include:

1. Immersion in molten metals or in certain molten salt baths
2. Where the unsupported tube length exceeds 36" vertically or 18" horizontally
3. Where furnace atmosphere pressure is more than 1 psig
4. Where work in the furnace may strike the tube
5. Where work is withdrawn frequently, resulting in excessive thermal shock.

Ceramic tubes are available in the materials listed on the next page; tubes of other materials, when required, can usually be supplied on special order.

Thermowells

Well-type assemblies are designed for use in liquids or gases at high pressure, such as in pipe-lines of oil refineries and steam-power plants, pressure tanks, vats and pumping stations. The use of a thermowell rather than a protection tube becomes imperative at pressures above 50 psig, although it can be used at lower pressures. Protection wells are drilled construction, made from solid bar stock. Safe working pressure varies widely, and depends upon the material of the well and the temperature and rate of flow of the medium.

For applications involving specific conditions, a computerized Design Analysis Certification can be supplied on special order. A completely generalized computer program has been written, to determine if a well of specified dimensions and material is strong enough to withstand anticipated conditions of temperature, pressure, velocity and vibration. The ASME Power Test Code for Thermometer Wells (PTC 19.3) provides the theoretical basis for the program, which specifically evaluates forces imposed by static pressure, steady-state fluid impingement, vibration induced by Karman trail vortices, and structure-borne vibrations. Details are available on request.

Thermowells supplied by L&N are usually made of carbon steel, Type 304, 316 or 347 stainless steel, Inconel, R-Monel, or F-11 or F-22 Alloy (see page 23). Other materials can be supplied on request.

METAL AND METAL-CERAMIC PROTECTION-TUBE AND THERMOWELL MATERIALS

Materials described below are, in general, arranged in the order of their increasing resistance to oxidation, increasing mechanical strength at elevated temperatures, and increasing limit of useful temperatures.

Material	Recommended Maximum Temperature	Description
Carbon Steel	1000 F (540 C)	Satisfactory in any except corrosive atmospheres.
Yoloy (Nickel-Copper Alloy Steel)	1300 F (700 C)	Resistant to corrosion in both oxidizing and reducing environments. Ideally suited for use in condensate return lines, salt-water and brine solutions, condenser water lines, vent and waste piping, or corrosive water lines.
Cast Iron	1300 F (700 C)	Generally more useful than Yoloy in the chemical industry. Resistant to concentrated sulfuric acid and caustic solutions. Can be used to 1600 F (870 C) in reducing atmospheres.
304 SS (18% Chromium, 8% Nickel)	1600 F (870 C)	Resistant to oxidation and corrosion. Generally used in wet-process applications such as steam lines, oil refineries and chemical solutions. Resists nitric acids well, halogen acids poorly, and the sulfur acids moderately.
316 SS (18% Chromium, 8% Nickel, 2% Molybdenum)	1600 F (870 C)	Superior to 304 SS in corrosion resistance. Resists pitting in phosphoric and acetic acids.
446 SS (28% Chromium, Iron)	2000 F (1090 C)	Excellent corrosion resistance at high temperatures. Used extensively in general-purpose alloy tubes. Highly resistant to sulfur attack.
Nickel	2000 F (1090 C)	Resistant to attack by many chemicals at high temperatures. Principally used for hot caustic and molten-salt baths. Should not be used where sulfur is present.
Inconel 600 (80% Nickel, 15% Chromium)	2100 F (1150 C)	For general high-temperature use. Has greater mechanical strength than 446 SS. Should not be used in sulfur atmospheres.
R-Monel (67% Nickel, 30% Copper)	900 F (480 C)	Used where high strength and resistance to corrosion are required, such as sea water, dilute sulfuric acid and strong caustic solutions.
F-11 (1¼% Chromium, ½% Molybdenum)	1100 F (590 C)	Generally used in power plants, on water and steam line applications. (Available in thermowells only.)
F-22 (2¼% Chromium, 1% Molybdenum)	1100 F (590 C)	Same as F-11, except has better oxidation resistance.
LT-1 (77% Chromium, 23% Aluminum Oxide)	2500 F (1370 C)	For high-temperature applications. Intermediate between metal and ceramic tubes, it has good thermal and mechanical shock resistance.

CERAMIC TUBE MATERIALS

Material	Recommended Maximum Temperature	Description
L&N Fyrestan	2800 F(1540 C)	A highly refractory porcelain, normally used for primary protection and often for secondary protection. L&N Fyrestan tubes can be substituted in many applications for nickel or chromium-alloy tubes, and although not as strong as metal alloys, are fully as gas-tight. Having a softening point of 3000 F (1650 C), these tubes can be mounted vertically at a temperature of 2800 F (1540 C) When mounted horizontally, the recommended maximum temperatures are 2750, 2650, 2500 and 2300 F (1500, 1450, 1370 and 1260 C) for unsupported lengths of 3, 6, 12 and 18 inches, respectively. The tubes are impervious to air to 3000 F (1650 C) and to dry hydrogen to 2550 F (1400 C). Their low rate of thermal expansion gives good thermal shock resistance
High-Purity Alumina	3400 F (1870 C)	A highly refractory 99+% pure alumina, normally used for primary or secondary protection. Alumina tubes have excellent deformation resistance and superior resistance to reducing atmospheres and chemical reactions at temperatures as high as 3400 F (1870 C) (If the tube is mounted horizontally, it must be supported at temperatures above 3000 F (1650 C).) Its excellent resistance to oxidizing and reducing atmospheres, as well as its exceptional stability at elevated temperatures, makes this material the ideal choice for protection of precious-metal thermocouples—especially Type B. These tubes are highly resistant to corrosive alkaline vapors and aluminum chloride vapors, and are stable to acids, alkalis, molten metals, most glass fluxes, molten salts and slags. The tubes are also impermeable to most gases under the conditions found in industrial furnaces.
Silicon Carbide Refractory	3000 F (1650 C)	Highly resistant to the cutting action of flames and gases and the corrosive effects of SO_2, tubes of silicon carbide refractory can be used for primary as well as secondary protection for temperatures up to 3000 F (1650 C) Ceramic-bonded silicon carbide features high thermal conductivity, high thermal-shock resistance, high strength and low permeability at differential pressures less than 2″ to 3″ H_2O

RECOMMENDED PROTECTION TUBE AND THERMOWELL MATERIALS

The following information, based on long practical experience, is offered as a guide to the selection of materials. Caution should be exercised in applying these recommendations to specific applications.

HEAT TREATING

Annealing	
Up to 1300 F (700 C)	Yoloy
Over 1300 F (700 C)	28% Chromium-Iron or Inconel
Carburizing, Hardening	
Up to 1500 F (815 C)	Yoloy or 28% Chromium-Iron
1500 F to 2000 F (815 to 1090 C)	28% Chromium-Iron or Inconel
Over 2000 F (1090 C)	Ceramic
Nitriding	28% Chromium-Iron
Salt Baths	
Cyanide	Nickel
Neutral	28% Chromium-Iron
High-Speed	Ceramic

IRON AND STEEL

Basic Oxygen Furnace	Quartz
Blast Furnaces	
Downcomer	Inconel, 28% Chromium-Iron
Stove Dome	Silicon Carbide, Cermet
Hot Blast Main	Inconel
Stove Trunk	Inconel
Stove Outlet Flue	Yoloy
Open Hearth	
Flues and Stack	Inconel, 28% Chromium-Iron
Checkers	Inconel, Cermet
Waste Heat Boiler	28% Chromium-Iron, Inconel
Billet-Heating, Slab-Heating and Butt Welding	
Up to 2000 F (1090 C)	28% Chromium-Iron, Inconel
Over 2000 F (1090 C)	Ceramic, Silicon Carbide
Bright Annealing, Batch	
Top Work Temperature	Not Required (Use bare Type J Thermocouple)
Bottom Work Temperature	28% Chromium-Iron
Continuous Furnace Section	Inconel, Ceramic
Forging	Silicon Carbide, Ceramic
Soaking Pits	
Up to 2000 F (1090 C)	Inconel
Over 2000 F (1090 C)	Ceramic, Silicon Carbide, Cermet

NON-FERROUS METALS

Aluminum	
Melting	Cast Iron (White-washed)
Heat Treating	Yoloy
Brass or Bronze	Not Required (Use Dip-Type Thermocouple)
Lead	28% Chromium-Iron, Yoloy, Cermet (650 F, 340 C)
Magnesium	Yoloy, Cast Iron
Tin	XH Carbon Steel, Cermet
Zinc	XH Carbon Steel, Cermet (1600 F, 870 C)
Pickling Tanks	Chemical Lead

CEMENT

Exit Flues	Inconel, 28% Chromium-Iron
Kilns—Heating Zone	Inconel

CERAMIC

Kilns	Ceramic and Silicon Carbide
Dryers	Yoloy, Silicon Carbide
Vitreous Enameling	Inconel, 28% Chromium-Iron

GLASS

Forehearths and Feeders	Platinum Thimble
Lehrs	Yoloy
Tanks	
Roof and Wall	Ceramic
Flues and Checkers	28% Chromium-Iron, Inconel

PAPER

Digesters	Type 316 SS, 28% Chromium-Iron

PETROLEUM

Dewaxing	Type 304 SS or Carbon Steel
Towers	Type 304 SS or Carbon Steel
Transfer Lines	Type 304 SS or Carbon Steel
Fractionating Column	Type 304 SS or Carbon Steel
Bridgewall	Type 304 SS or Carbon Steel

POWER

Coal-Air Mixtures	Type 304 SS
Flue Gases	Yoloy or 28% Chromium-Iron
Preheaters	Yoloy or 28% Chromium-Iron
Steam Lines	Type 347 SS or 316 SS
Water Lines	Carbon Steel, Yoloy
Boiler Tubes	Type 309 or 310 SS

GAS PRODUCERS

Producer Gas	28% Chromium-Iron
Water Gas	
Carburetor	Inconel, 28% Chromium-Iron
Superheater	Inconel, 28% Chromium-Iron
Tar Stills	Carbon Steel

INCINERATORS

Up to 2000 F (1090 C)	28% Chromium-Iron, Inconel
Over 2000 F (1090 C)	Ceramic (Primary), Silicon Carbide (Secondary)

FOOD

Baking Ovens	Yoloy
Char Retort, Sugar	Yoloy
Vegetables and Fruit	Type 304 SS

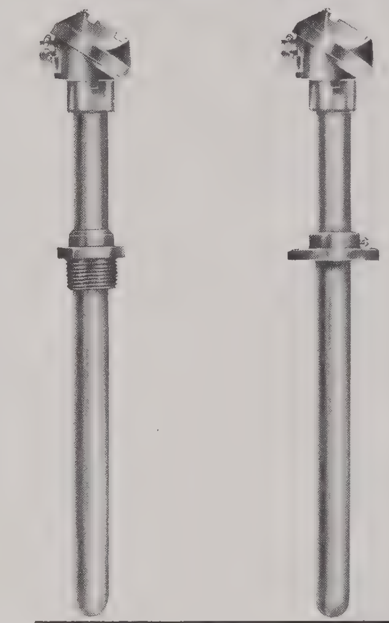
CHEMICAL

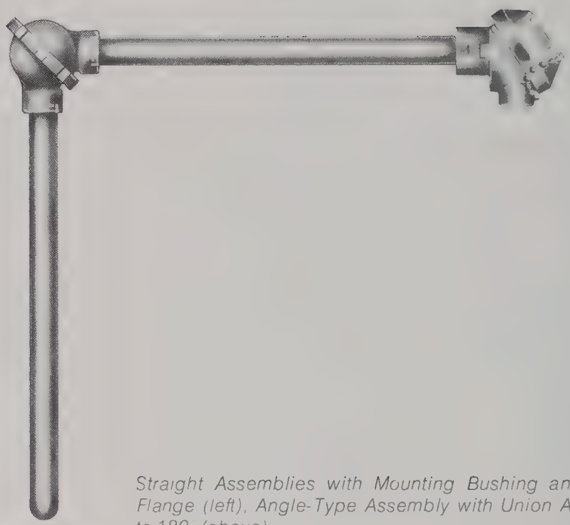
Acetic Acid	
10 to 50%, 70 F (21 C)	Type 304 SS
50%, 212 F (100 C)	Type 316 SS
99%, 70 to 212 F (21 to 100 C)	Type 430 SS
Alcohol, Ethyl, Methyl	
70 to 212 F (21 to 100 C)	Type 304 SS
Ammonia	
All Concentration, 70 F (21 C)	Type 304 SS
Ammonium Chloride	
All Concentration, 212 F (100 C)	Type 316 SS
Ammonium Nitrate	
All Concentration, 70 to 212 F (21 to 100 C)	Type 304 SS
Ammonium Sulphate	
10% to Saturated, 212 F (100 C)	Type 316 SS
Barium Chloride	
All Concentration, 70 F (21 C)	Monel
Barium Hydroxide	
All Concentration, 70 F (21 C)	Carbon Steel
Barium Sulphite	Nichrome
Brines	Monel
Bromine	Tantalum
Butadiene	Type 304 SS
Butane	Type 304 SS
Butyl Acetate	Monel
Butyl Alcohol	Copper
Calcium Chlorate	
Dilute, 70 to 150 F (21 to 65 C)	Type 304 SS
Calcium Hydroxide	
10% to 20%, 212 F (100 C)	Type 304 SS
50%, 212 F (100 C)	Type 316 SS
Carbolic Acid	
All, 212 F (100 C)	Type 316 SS
Carbon Dioxide, Wet or Dry	2017-T4 Aluminum, Monel

CHEMICAL *Continued*

Chlorine Gas	
Dry, 70 F (21 C)	Type 316 SS
Moist, 20 to 212 F (−6 to 100 C)	Hastelloy C
Chromic Acid	
10 to 50%, 212 F (100 C)	Type 316 SS
Citric Acid	
15%, 70 F (21 C)	Type 304 SS
15%, 212 F (100 C)	Type 316 SS
Concentrated, 212 F (100 C)	Type 316 SS
Copper Nitrate	Type 304 SS
Copper Sulphate	Type 304 SS
Creosols	Type 304 SS
Cyanogen Gas	Type 304 SS
Dowtherm	Carbon Steel
Ether	Type 304 SS
Ethyl Acetate	Monel
Ethyl Chloride, 70 F (21 C)	Type 304 SS
Ethyl Sulphate, 70 F (21 C)	Monel
Ferric Chloride	
5%, 70 F (21 C) to boiling	Tantalum
Ferric Sulphate	
5%; 70 F (21 C)	Type 304 SS
Ferrous Sulphate	
Dilute, 70 F (21 C)	Type 304 SS
Formaldehyde	Type 304 SS
Formic Acid	
5%; 70 to 150 F (21 to 65 C)	Type 316 SS
Freon	Monel
Gallic Acid	
5%, 70 to 150 F (21 to 65 C)	Monel
Gasoline, 70 F (21 C)	Type 304 SS
Glucose, 70 F (21 C)	Type 304 SS
Glycerine, 70 F (21 C)	Type 304 SS
Glycerol	Type 304 SS
Hydrobromic Acid	
98%, 212 F (100 C)	Hastelloy B
Hydrochloric Acid	
1%, 5%; 70 F (21 C)	Hastelloy C
1%, 5%; 212 F (100 C)	Hastelloy B
25%, 70 to 212 F (21 to 100 C)	Hastelloy B
Hydrofluoric Acid	Hastelloy C
Hydrogen Peroxide	
70 to 212 F (21 to 100 C)	Type 316 SS
Hydrogen Sulphide, Wet and Dry	Type 316 SS
Iodine, 70 F (21 C)	Tantalum
Lactic Acid	
5%, 70 F (21 C)	Type 304 SS
5%, 212 F (100 C)	Type 316 SS
10%, 212 F (100 C)	Tantalum
Magnesium Chloride	
5%, 70 F (21 C)	Monel
5%, 212 F (100 C)	Nickel
Magnesium Sulphate, Hot and Cold	Monel
Muriatic Acid, 70 F (21 C)	Tantalum
Naphtha, 70 F (21 C)	Type 304 SS
Natural Gas, 70 F (21 C)	Type 304 SS
Nickel Chloride, 70 F (21 C)	Type 304 SS
Nickel Sulphate, Hot and Cold	Type 304 SS
Nitric Acid	
5%, 70 F (21 C)	Type 304 SS
20%, 70 F (21 C)	Type 304 SS
50%, 70 F (21 C)	Type 304 SS
50%, 212 F (100 C)	Type 304 SS
65%, 212 F (100 C)	Type 316 SS
Concentrated, 70 F (21 C)	Type 304 SS
Concentrated, 212 F (100 C)	Tantalum
Nitrobenzene, 70 F (21 C)	Type 304 SS
Oleic Acid, 70 F (21 C)	Type 316 SS
Oleum, 70 F (21 C)	Type 316 SS
Oxalic Acid	
5%, Hot and Cold	Type 304 SS
10%, 212 F (100 C)	Monel
Oxygen	
70 F (21 C)	Steel
Liquid	Stainless Steel
Elevated Temperatures	Stainless Steel
Palmitic Acid	Type 316 SS
Pentane	Type 304 SS
Phenol	Type 304 SS
Phosphoric Acid	
1%, 5%; 70 F (21 C)	Type 304 SS
10%, 70 F (21 C)	Type 316 SS
10%, 212 F (100 C)	Hastelloy C
30%, 70 to 212 F (21 to 100 C)	Hastelloy B
85%, 70 to 212 F (21 to 100 C)	Hastelloy B
Picric Acid, 70 F (21 C)	Type 304 SS
Potassium Bromide, 70 F (21 C)	Type 316 SS
Potassium Carbonate	
1%, 70 F (21 C)	Type 304 SS
Potassium Chlorate, 70 F (21 C)	Type 304 SS
Potassium Hydroxide	
5%, 70 F (21 C)	Type 304 SS
25%, 212 F (100 C)	Type 304 SS
60%, 212 F (100 C)	Type 316 SS
Potassium Nitrate	
5%, 70 F (21 C)	Type 304 SS
5%, 212 F (100 C)	Type 304 SS
Potassium Permanganate	
5%, 70 F (21 C)	Type 304 SS
Potassium Sulphate	
5%, 70 F (21 C)	Type 304 SS
Potassium Sulphide, 70 F (21 C)	Type 304 SS
Propane	Type 304 SS
Pyrogallic Acid	Type 304 SS
Quinine Bisulphate, Dry	Type 316 SS
Quinine Sulphate, Dry	Type 304 SS
Sea Water	Monel
Salicylic Acid	Nickel
Sodium Bicarbonate	
All Concentration, 70 F (21 C)	Type 304 SS
5%, 150 F (65 C)	Type 304 SS
Sodium Carbonate	
5%, 70 to 150 F (21 to 65 C)	Type 304 SS
Sodium Chloride	
5%, 70 to 150 F (21 to 65 C)	Type 316 SS
Saturated, 70 to 212 F (21 to 100 C)	Type 316 SS
Sodium Fluoride, 5%, 70 F (21 C)	Monel
Sodium Hydroxide	Type 304 SS
Sodium Hypochlorite, 5% Still	Type 316 SS
Sodium Nitrate, Fused	Type 316 SS
Sodium Peroxide	Type 304 SS
Sodium Sulphate, 70 F (21 C)	Type 304 SS
Sodium Sulphide, 70 F (21 C)	Type 316 SS
Sodium Sulphite, 150 F (65 C)	Type 304 SS
Sulphur Dioxide	
Moist Gas, 70 F (21 C)	Type 316 SS
Gas, 575 F (300 C)	Type 304 SS
Sulphur	
Dry, Molten	Type 304 SS
Wet	Type 316 SS
Sulphuric Acid	
5%, 70 to 212 F (21 to 100 C)	Hastelloy B
10%, 70 to 212 F (21 to 100 C)	Hastelloy B
50%, 70 to 212 F (21 to 100 C)	Hastelloy B
90%, 70 F (21 C)	Hastelloy B
90%, 212 F (100 C)	Hastelloy D
Tannic Acid, 70 F (21 C)	Type 304 SS
Tartaric Acid	
70 F (21 C)	Type 304 SS
150 F (65 C)	Type 316 SS
Toluene	2017-T4 Aluminum
Turpentine	Type 304 SS
Whiskey and Wine	Type 304 SS
Xylene	Copper
Zinc Chloride	Monel
Zinc Sulphate	
5%, 70 F (21 C)	Type 304 SS
Saturated, 70 F (21 C)	Type 304 SS
25%, 212 F (100 C)	Type 304 SS

3070-Series in Straight and Angle-Type Metal Protection Tubes





Straight Assemblies with Mounting Bushing and Adjustable Flange (left), Angle-Type Assembly with Union Adjustable 90 to 180 (above)

- **Straight or angle-type industrial assemblies**
- **Single or dual elements**
- **Choice of base-metal thermocouples—Type E, J, K, T or N—with grounded or ungrounded junctions**
- **Wide choice of protection tube materials and sizes**
- **Weather-resistant aluminum or heat-and-moistureproof cast-iron Universal Heads**
- **Adjustable flanges or welded bushings to facilitate mounting**
- **Optional calibration checks at specified temperatures**
- **Ordering complete assemblies, replacement elements or replacement tubes simplified by catalog numbering**

These assemblies find the broadest possible industrial application: wherever a base-metal thermocouple is to be exposed to an atmosphere or fluid at ordinary pressures (up to 50 psig)

A 3070-Series Straight-Type Assembly comprises either a single- or dual-element thermocouple housed in a metal protection tube with a Universal Head for terminal connections

A 3071-Series Angle-Type Assembly utilizes a similar metal protection tube ("hot leg"), a union adjustable from 90° to 180°, a Yoloy tube ("cold leg") and a Universal Head, to house a single-element thermocouple. This angle-type assembly is generally used where the Head must be remote from a hot location, or protected from the heat which would be conducted to it directly by a "hot leg" The adjustable assembly also permits critical positioning of the thermocouple, and aids in working around obstructions

THERMOCOUPLE TYPES

Type J (iron-constantan) thermocouples should be specified for general use up to 1400 F in oxidizing or reducing atmospheres. Featuring high and fairly uniform sensitivity in millivolts degree change, comparatively low cost, and excellent service life in both oxidizing and reducing atmospheres, Type J is the most widely used of all industrial thermocouples

Type K (nickel, chromium-nickel, aluminum) should be specified where a moderate-cost sensor is required for high-temperature measurements in oxidizing atmospheres. Type K is most commonly used over the range of 1400 to 2300 F

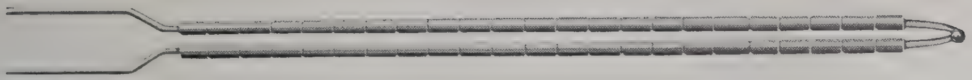
Type E (nickel, chromium-constantan) provides the highest millivolt degree output, for greatest sensitivity — makes this thermocouple especially useful (up to 1600 F) for short ranges or differential-temperature measurements

Type T (copper-constantan) is applicable in oxidizing and reducing atmospheres below 600 F . . . is highly stable at sub-zero temperatures, with a high conformity to published calibration data

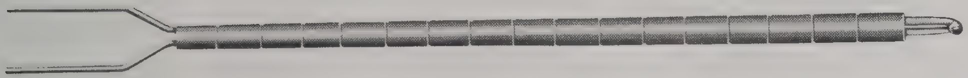
Type N (Nicrosil-Nisil) provides superior thermal stability, longer life and better accuracy for longer time periods than Type K. More resistant to green rot corrosion and reducing atmospheres

THERMOCOUPLE ELEMENTS

Straight-Type Assemblies (3070-Series): Available with single or dual element Single element comprises 8 AWG wires in single-hole or two-hole ceramic insulators or 14 AWG wires in two-hole insulators Dual element is available as 14 AWG wires only, in one-piece four-hole ceramic insulators, or as two separate elements, each in two-hole insulators



Straight-Type Element: Wires with Single-Hole Insulators



Straight-Type Element: Wires with Double-Hole Insulators

Angle-Type Assemblies (3071-Series): Available with a single element only, comprising 8 AWG wires with one-piece two-hole ceramic insulators on "cold leg" and "hot leg" extensions, and single-hole fish-spine insulators at the bend.

THERMOCOUPLE JUNCTIONS

If an open-end protection tube is employed, the junction is naturally exposed and ungrounded. In a closed-end tube, the junction can be specified grounded to the bottom of the tube, or insulated from the bottom of the tube by a ceramic cup. When dual junctions are ungrounded, they are insulated from each other as well as the bottom of the tube.

HEAD ASSEMBLIES

Universal Heads are available in either aluminum or cast-iron construction, with single- or dual-element terminal connectors.

Aluminum: Compact, lightweight, weathertight housing has highly polished, corrosion-resistant cap and base, joined by a beaded chain. By compressing a high-temperature silicone-rubber gasket, the cap is quickly and easily secured to the body . . . a quarter turn locks or releases it. Slots across the cap permit applying leverage, simplifying its removal even when hot. The thermocouple opening is tapped ¼", ½", ¾" or 1" NPT, depending upon the size of the protection tube; the conduit opening is tapped ½" NPT. (To convert to ¾" NPT, an adapter can be ordered as an option.)

Cast-Iron: Sturdy cast-iron head features rugged construction for long life in heavy industrial applications. A heat-and-moistureproof gasket forms a watertight seal between the threaded cap-to-base connection. Cap — secured by a heavy chain — has slots to permit leverage. Thermocouple opening is tapped ¼", ½", ¾" or 1" NPT; conduit opening is tapped ¾" NPT. (To convert to ½" NPT, a reducer can be ordered as an option.)

PROTECTION TUBES

Straight-Type Assemblies (3070-Series): Protection tubes are available in sizes from ¼" IPS to ⅞" ID × 1⅜" OD, in a wide range of materials, with either closed-end or open-end construction. To facilitate mounting, an adjustable flange may be specified, or a mounting bushing may be welded to the tube

Angle-Type Assemblies (3071-Series): An angle-type assembly comprises a Universal Head, a Yoloy tube threaded on both ends ("cold leg"), an adjustable union, and a closed-end or open-end protection tube ("hot leg"). Since the cold leg (and union) are available for either ½" or 1" NPT connections, the protection tube selected as the hot leg must be of compatible size. Flanges or mounting bushings can also be specified.

CALIBRATION DATA OPTION

Correction data can be supplied for any specified temperature point(s) between −100 and 2300 F, depending upon wire type, gauge and insulation. Data is provided on a linen tag, wired to the element or assembly . . . can also be provided in a typed report.

HOW TO ORDER

The catalog numbering system simplifies ordering (a) a complete assembly — element, head, protection tube (with or without a cold leg and union); (b) a replacement element; or (c) a replacement protection tube. (Any of these can be ordered tagged for temporary or permanent identification.)

In sequence, the catalog number comprises:

- a base number to define a straight (3070) or angle-type (3071) assembly;
- Suffix A, B, C and D to describe the element: construction, type, junction and length;
- Suffix E to specify the head assembly;
- Suffix G to specify the "cold leg" and union (angle-type assemblies only);
- a base number (Suffix H) to specify the size of the "hot leg" (ID and OD), with Suffixes Ha to He to specify material, length, optional mounting fitting, and tube-end construction; and
- Suffix J to specify any options.

Note: To order individual parts not covered by this system, see table, "Component Part Numbers"

EXAMPLES

3070-2-J-2-36-2-3245-5-36-0-0-1-000

Specifies a straight-type assembly **(3070)** with single-element 8 AWG wires in 2-hole ceramic insulators **(2)**, Type J **(J)**, ungrounded junction **(2)**, 36 inches long **(36)**; cast-iron head **(2)**; 1" std protection tube **(3245)**, Inconel **(5)**, 36 inches long **(36)**, no mounting fittings **(0-0)**, closed-end construction **(1)**, no options **(000)**.

Replacement Element: 3070-2-J-2-36-0-0-000.

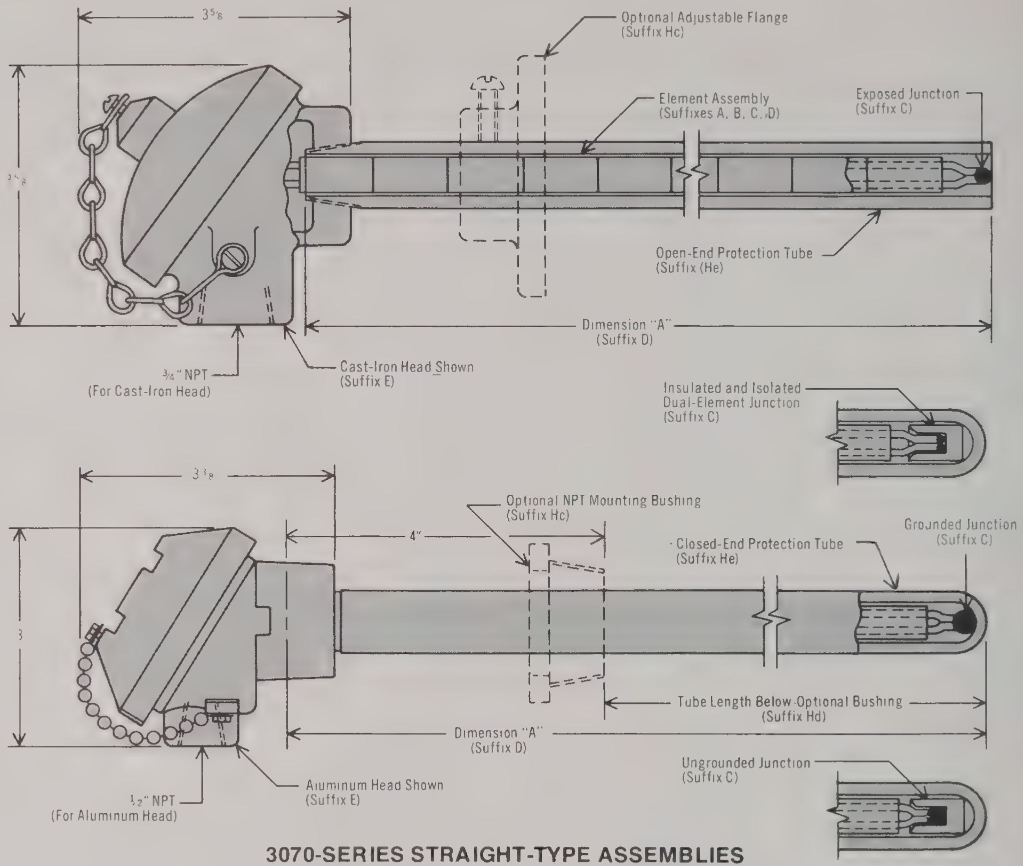
Replacement Protection Tube: 3245-5-36-0-0-1-000.

3071-1-E-1-48-2-1-3241-8-27-0-0-1-000.

Specifies an angle-type assembly **(3071)** with single-element 8 AWG wires in 2-hole insulators with fish-spine insulators at the bend **(1)**, Type E **(E)**, grounded junction **(1)**, 48 inches long: 18" + 3" + 27": **(48)**; cast-iron head **(2)**, ½" std Yoloy cold leg, 18" long, with ½" universal union **(1)**; ½" std protection tube **(3241)**, 446 SS **(8)**, 27 inches long **(27)**, no mounting fittings **(0-0)**, closed-end construction **(1)**, no options **(000)**.

Replacement Element: 3071-1-E-1-48-0-1-0-000.

Replacement Protection Tube: 3241-8-27-0-0-1-000.


3⅝
3⅝
Optional Adjustable Flange (Suffix Hc)
Element Assembly (Suffixes A, B, C, D)
Exposed Junction (Suffix C)
Open-End Protection Tube (Suffix He)
Dimension "A" (Suffix D)
¾" NPT (For Cast-Iron Head)
Cast-Iron Head Shown (Suffix E)
Insulated and Isolated Dual-Element Junction (Suffix C)
3⅜
3
4"
Optional NPT Mounting Bushing (Suffix Hc)
Closed-End Protection Tube (Suffix He)
Grounded Junction (Suffix C)
Tube Length Below Optional Bushing (Suffix Hd)
Dimension "A" (Suffix D)
½" NPT (For Aluminum Head)
Aluminum Head Shown (Suffix E)
Ungrounded Junction (Suffix C)

3070-SERIES STRAIGHT-TYPE ASSEMBLIES

A B C D E H Ha Hb Hc Hd He J
Assembly Catalog Number: **3070–☐–☐–☐–☐☐–☐–32☐☐–☐–☐☐–☐–☐☐–☐–☐☐☐**

A B C D E H J
Replacement Element: **3070–☐–☐–☐–☐☐–0–0–☐☐☐**

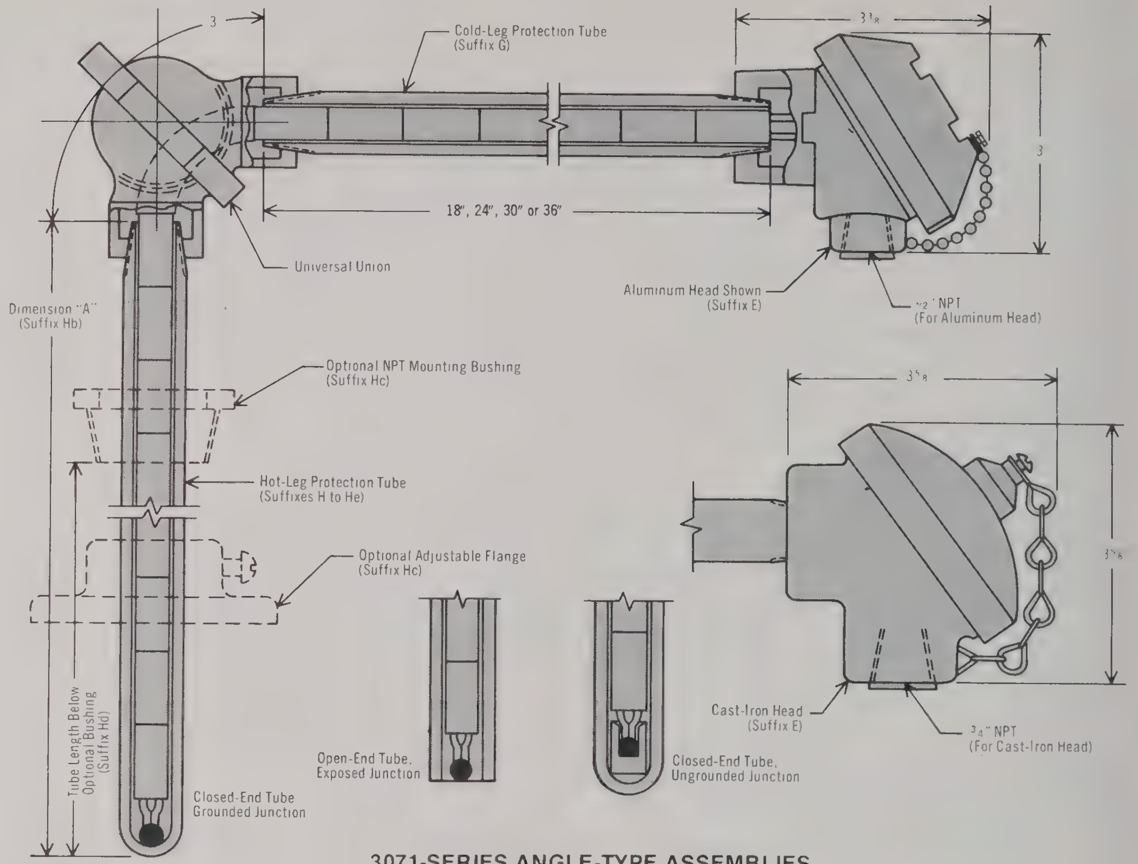
H Ha Hb Hc Hd He J
Replacement Tube: **32☐☐–☐–☐☐–☐–☐☐–☐–☐☐☐**

	Description		Suffix
Suffix A: Element Construction	Single Element	8 AWG Wires in 2-Hole Ceramic Insulators (Will not fit in 3240 Protection Tube)*	2
		14 AWG Wires in 2-Hole Ceramic Insulators	3
	Dual Element	14 AWG Wires in 4-Hole Ceramic Insulators**	5
Suffix B. Thermocouple Type (See Table, Page 2, for Temperature Limits vs Wire Gauge)	Single Element	Nickel, Chromium-Constantan Iron-Constantan Nickel, Chromium-Nickel, Aluminum Copper-Constantan Nicrosil-Nisil	E J K T N
	Dual Element	Nickel, Chromium-Constantan Iron-Constantan Nickel, Chromium-Nickel, Aluminum Copper-Constantan Nicrosil-Nisil	EE JJ KK TT NN
Suffix C: Type of Junction	Exposed Ungrounded Junction (Specify for Open-End Tube Only: Suffix He-2) Grounded to Bottom of Tube Ungrounded Junction, Insulated from Bottom of Tube by Ceramic Cup Dual-Element Junctions, Isolated and Insulated from Each Other and Bottom of Tube		0 1 2 3
Suffix D: Element Length	Specify Element Length (Dimension "A") in **Inches** (6" Min., 144" Max.)		

[illegible]

	Description		Suffix
Suffix E: Head Assembly	None (Specified When Ordering Replacement Element Only)		0
	Aluminum Head, Twist Cap (Tapped for ½" NPT Conduit)		1
	Cast Iron Head, Screw Cap (Tapped for ¾" NPT Conduit)		2
Suffix H-Ha: Protection Tube Size and Material	None (Specified When Ordering Replacement Element Only)		0
	Cast Iron (1300 F, Max.)	⅞" ID x 1⅜" OD	3250-1
	Yoloy, Welded (Nickel-Copper Alloy Steel; 1300 F, Max.)	½" Std	3241-2
		½" XH	3242-2
		¾" Std	3243-2
		¾" XH	3244-2
		1" Std	3245-2
		1" XH	3246-2
	Seamless Steel, Drawn (Carbon Steel; 1000 F, Max.)	¼" Std	3240-3
		½" Std	3241-3
		½" XH	3242-3
		13/16" ID x 1 5/16" OD	3248-3
	Nickel (2000 F, Max.)	½" Std (Drawn)	3241-4
		1" Std (Drawn)	3245-4
		17/32" ID x ⅞" OD (Drilled)	3249-4
		⅞" ID x 1⅜" OD (Drilled)	3250-4
	Inconel 600, Drawn (80% Nickel, 15% Chromium; 2100 F, Max.)	½" Std	3241-5
		¾" Std	3243-5
		1" Std	3245-5
	304 SS, Drawn (18% Chromium, 8% Nickel; 1600 F, Max.)	¼" Std	3240-6
		½" Std	3241-6
		½" XH	3242-6
		¾" Std	3243-6
		1" Std	3245-6
		1" XH	3246-6
	316 SS, Drawn (18% Chromium, 8% Nickel, 2% Molybdenum; 1600 F, Max.)	½" Std	3241-7
		¾" Std	3243-7
		1" Std	3245-7
	446 SS (28% Chromium -Iron; 2000 F, Max.)	¼" Std (Drawn)	3240-8
		½" Std (Drawn)	3241-8
		¾" Std (Drawn)	3243-8
		1" Std (Drawn)	3245-8
		⅝" ID x 1⅛" OD (Drilled)	3247-8
		⅞" ID x 1⅜" OD (Drilled)	3250-8
Suffix Hb: Protection Tube Length	Specify Protection Tube Length, Dimension "A", in **Inches** (6" Min. for All Tubes; 48" Max. for 3250-1; 60" Max. for Drilled Tubes; 144" Max. for All Others)		
Suffix Hc: Mounting Fitting	None		0
	Adjustable Pipe Flange, 1⅛" x 3¼" OD (All Tubes)		1
	½" NPT Mounting Bushing, 1" Hex, ¾" Long (3240 Tube Only)		2
	¾" NPT Mounting Bushing, 1¼" Hex, ⅞" Long (3240 Tube Only)		3
	1" NPT Mounting Bushing, 1⅜" Hex, 1" Long (3240, 3241, 3242 or 3249 Tube Only)		4
	1¼" NPT Mounting Bushing, 1¾" Hex, 1¼" Long (All Tubes Except 3250)		5
	1½" NPT Mounting Bushing, 2⅜" Hex, 1⅜" Long (All Tubes)		6
	2" NPT Mounting Bushing, 2⅞" Hex, 1⅜" Long (All Tubes)		7
Suffix Hd: Tube Length Below Bushing	None (Specified When Suffix Hc is Either "0" or "1")		0
	Specify Tube Length Below Welded Bushing, to Hot End of Tube, in **Inches*****		
Suffix He: Tube-End Construction	Closed-End Construction		1
	Open-End Construction (Suffix C must be "0")		2
Suffix J: Options	None		000
	Tagging	1 Linen Tag (Specify Legend)	206
		1 Aluminum Tag, Machine-Stamped, 15 Characters Max. (Specify Legend)	207
		1 Stainless-Steel Tag, Electro-Etched, 22 Characters Max. on Each of Three Lines (Specify Legend)	208
	Calibration	Calibration Check(s): Correction Data Supplied for Any Specified Point(s) Between - 100 and 2300 F (Minimum Element Length, 24".)	
		Correction Data Supplied on Linen Tag	300
		Correction Data Supplied in Typed Report, plus Linen Tag	301
	Universal-Head Conduit Adapter	Converts Aluminum Head ½" NPT Conduit Opening for ¾" NPT Conduit	130
		Converts Cast-Iron Head ¾" NPT Conduit Opening for ½" NPT Conduit	131
	Grounding Connection	Ground Screw Provided Inside Aluminum or Cast-Iron Universal Head for Drain Wire in Conduit Cable	150

****When a bushing is to be welded on the tube as close as possible to the head end, Suffix Hd should be specified as the Suffix Hb dimension minus 4". If no bushing [illegible] 0 for Suffix Hd*


3
Cold-Leg Protection Tube
(Suffix G)
3⅜
3
18", 24", 30" or 36"
Universal Union
Aluminum Head Shown
(Suffix E)
½" NPT
(For Aluminum Head)
Dimension "A"
(Suffix Hb)
Optional NPT Mounting Bushing
(Suffix Hc)
3⅝
3⅝
Hot-Leg Protection Tube
(Suffixes H to He)
Optional Adjustable Flange
(Suffix Hc)
Tube Length Below
Optional Bushing
(Suffix Hd)
Cast-Iron Head
(Suffix E)
¾" NPT
(For Cast-Iron Head)
Open-End Tube,
Exposed Junction
Closed-End Tube,
Ungrounded Junction
Closed-End Tube
Grounded Junction

3071-SERIES ANGLE-TYPE ASSEMBLIES

A B C D E G H Ha Hb Hc Hd He J

Assembly Catalog Number: **3071–1–☐–☐–☐☐–☐–☐–32☐☐–☐–☐☐–☐–☐☐–☐–☐☐☐**

A B C D E G H J

Replacement Element: **3071–1–☐–☐–☐☐–0–☐–0–☐☐☐**

H Ha Hb Hc Hd He J

Replacement Hot Leg: **32☐☐–☐–☐☐–☐–☐☐–☐–☐☐☐**

	Description			Suffix
Suffix A: Element Construction	Single-Element Only: 8 AWG Wires in 2-Hole Ceramic Insulators, with Single Hole Fish-Spine Insulators at Bend			1
Suffix B: Thermocouple Type (See Table, Page 2, for Temperature Limits vs Wire Gauge)	Nickel, Chromium-Constantan (1600 F, Max.) Iron-Constantan (1400 F, Max.) Nickel, Chromium-Nickel, Aluminum (2300 F, Max.) Copper-Constantan (700 F, Max.) Nicrosil-Nisil (2300 F, Max.)			E J K T N
Suffix C: Type of Junction	Exposed Ungrounded Junction (Specify for Open End Tube Only: Suffix He-2) Grounded to Bottom of Tube Ungrounded: Junction Insulated from Bottom of Tube by Ceramic Cup			0 1 2
Suffix D: Element Length	Specify Element Length in **Inches**: Dimension "A" Plus Dimension of Cold Leg (Suffix G) Plus 3" (27" Min., 165" Max.)			☐☐
Suffix E: Head Assembly	None (Specified When Ordering Replacement Element Only) Aluminum Head (Tapped for ½" NPT Conduit) Cast-Iron Head (Tapped for ¾" NPT Conduit)			0 1 2
Suffix G: Protection Tube Cold Leg	Yoloy, Both Ends Open and Threaded	½" Std. Includes ½" Universal Union	18 Long 24 Long 30 Long 36 Long	1 3 5 7
		1" Std: Includes 1" Universal Union	18 Long 24 Long 30 Long 36 Long	2 4 6 8

	Description		Suffix
Suffix H-Ha: Protection Tube Size and Material, Hot Leg	None (Specified When Ordering Replacement Element Only)		0
	Cast Iron (1300 F, Max.)	⅞" ID x 1⅜" OD (1" NPT)	3250-1
	Yoloy, Welded (Nickel-Copper Alloy Steel; 1300 F, Max.)	½" Std ½" XH 1" Std 1" XH	3241-2 3242-2 3245-2 3246-2
	Seamless Steel, Drawn (Carbon Steel; 1000 F, Max.)	½" Std ½" XH 13/16" ID x 1 5/16" OD (1" NPT)	3241-3 3242-3 3248-3
	Nickel (2000 F, Max.)	½" Std (Drawn) 1" Std (Drawn) 17/32" ID x ⅞" OD (Drilled; ½" NPT) ⅞" ID x 1⅜" OD (Drilled; 1" NPT)	3241-4 3245-4 3249-4 3250-4
	Inconel 600, Drawn (80% Nickel, 15% Chromium; 2100 F, Max.)	½" Std 1" Std	3241-5 3245-5
	304 SS, Drawn (18% Chromium, 8% Nickel; 1600 F, Max.)	½" Std ½" XH 1" Std 1" XH	3241-6 3242-6 3245-6 3246-6
	316 SS, Drawn (18% Chromium, 8% Nickel, 2% Molybdenum; 1600 F, Max.)	½" Std 1" Std	3241-7 3245-7
	446 SS (28% Chromium-Iron; 2000 F, Max.)	½" Std (Drawn) 1" Std (Drawn) ⅞" ID x 1⅜" OD (Drilled; 1" NPT)	3241-8 3245-8 3250-8
Suffix Hb: Protection Tube Length, Hot Leg	Specify Protection Tube length, **Dimension "A"**, in **Inches** (6" Min. for All Tubes; 48" Max. for 3250-1; 60" Max. for Drilled Tubes; 144" Max. for All Others)		□□
Suffix Hc: Mounting Fitting	None Adjustable Pipe Flange, 1⅛" x 3¼" OD (All Tubes) 1" NPT Mounting Bushing, 1⅜" Hex, 1" Long (3241, 3242 or 3249 Tube Only) 1¼" NPT Mounting Bushing, 1¾" Hex, 1¼" Long (All Tubes Except 3250) 1½" NPT Mounting Bushing, 2⅜" Hex, 1⅜" Long (All Tubes) 2" NPT Mounting Bushing, 2⅞" Hex, 1⅜" Long (All Tubes)		0 1 4 5 6 7
Suffix Hd: Tube Length Below Bushing	None (Specified When Suffix Hc is Either "0" or "1") Specify Tube Length Below Bushing, to Hot End of Tube, in **Inches***		0 □□
Suffix He: Tube End	Closed-End Construction Open-End Construction (Suffix C must be "0")		1 2
Suffix J: Options	**Available options are the same as for the 3070-Series; see table on page 11.**		[

*When a bushing is to be welded on the tube as close as possible to the union end, Suffix Hd should be specified as the Suffix Hb dimension minus 4

COMPONENT PART NUMBERS

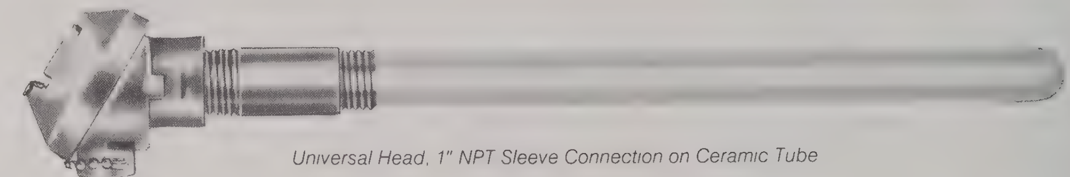
Protection Tube, Hot Leg					Protection Tube, Cold Leg	Universal Union**	Head Part Number***			
Base Part Number*	Pipe or Tube Size	Dimensions		Thread (NPT)			Aluminum		Cast-Iron	
		ID	OD				Single-Element	Dual-Element	Single-Element	Dual-Element
3240-	¼" Std	0.364"	0.540"	¼"	—	—	042191	042311	352244	042310
3241 3242- 3249	½" Std ½" XH 17/32" x ⅞"	0.622" 0.546" 0.531"	0.840" 0.840" 0.875"	½"	136034 (18") 020240 (24") 020241 (30") 020242 (36")	076052	042113	042306	352240	042304
3243 3244-	¾" Std ¾" XH	0.824" 0.742"	1.050" 1.050"	¾"	—	—	042309	042307	352245	042305
3247-	⅝" x 1⅛"	0.625"	1.125"							
3245 3246- 3248-	1" Std 1" XH 13/16" x 1 5/16"	1.049" 0.951" 0.8125"	1.315" 1.315" 1.3125"	1"	065124 (18") 020243 (24") 020244 (30") 020245 (36")	076077	042112	042192	352237	352241
3250	⅞" x 1⅜"	0.875"	1.375"							

*Same as Suffix H in 3070 or 3071 assembly

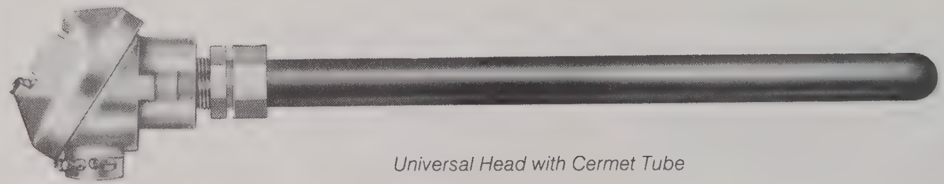
**Included with 3071 angle-type assembly

***Included with 3070 or 3071 assembly when "1" or "2" is specified for Suffix E. Thermocouple opening is tapped to accept thread of corresponding [illegible] opening is tapped ¾" NPT for cast-iron head, ½" NPT for aluminum (To convert ½" NPT to ¾" NPT, order an 076955 Adapter, to convert ¾" NPT t[illegible] Reducer.) To order a replacement Terminal Block, specify an 016338 Single-Element or 316236 Dual-Element Terminal

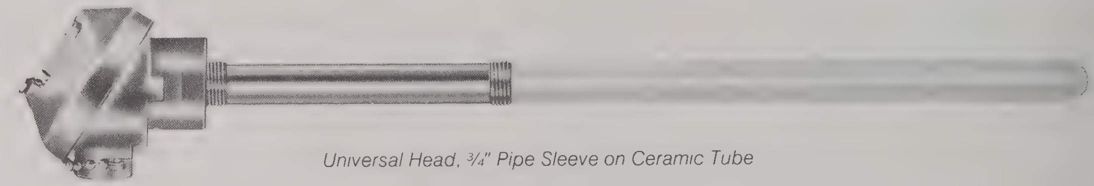
3072-Series in Ceramic Protection Tubes



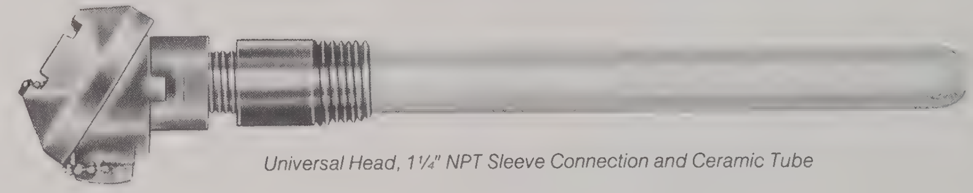
Universal Head, 1" NPT Sleeve Connection on Ceramic Tube



Universal Head with Cermet Tube



Universal Head, 3/4" Pipe Sleeve on Ceramic Tube



Universal Head, 1¼" NPT Sleeve Connection and Ceramic Tube

- **Single or dual elements**
- **Choice of base-metal thermocouples—Type E, J, K or N**
- **Wide choice of protection tube materials and sizes**
- **Weather-resistant aluminum or heat- and-moistureproof cast-iron Universal Heads**
- **Adjustable flanges or welded bushings to facilitate mounting**
- **Optional calibration checks at specified temperatures**
- **Ordering complete assemblies, replacement elements or replacement tubes simplified by catalog numbering**

The catalog 3072 offers base metal thermocouple elements in ceramic protection tubes. Many industrial applications such as salt baths, stove dome, lead, tin and incinerators utilize these assemblies due to environmental conditions.

A 3072 series assembly comprises either a single or dual element thermocouple housed in a ceramic or cermet protection with a universal head for termination.

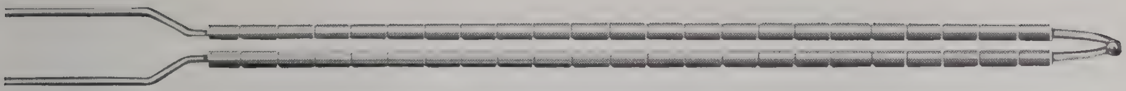
THERMOCOUPLE TYPES

Type J (iron-constantan) thermocouples should be specified for general use up to 1400 F in oxidizing or reducing atmospheres. Featuring high and fairly uniform sensitivity in millivolts/degree change, comparatively low cost, and excellent service life in both oxidizing and reducing atmospheres. Type J is the most widely used of all industrial thermocouples.

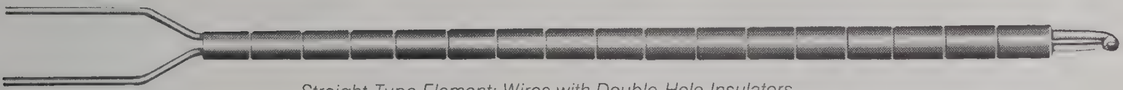
Type K (nickel, chromium-nickel, aluminum) should be specified where a moderate-cost sensor is required for high-temperature measurements in oxidizing atmospheres. Type K is most commonly used over the range of 1400 to 2300 F.

Type E (nickel, chromium-constantan) provides the highest millivolt/degree output, for greatest sensitivity—makes this thermocouple especially useful (up to 1600 F) for short ranges or differential-temperature measurements.

Type N (Nicrosil Nisil) provides superior thermal stability, longer life and better accuracy for longer time periods than type K. More resistant to green rot corrosion and reducing atmospheres. Range 32 to 2300 F.



Straight-Type Element: Wires with Single-Hole Insulators



Straight-Type Element: Wires with Double-Hole Insulators

THERMOCOUPLE ELEMENTS

Available with single or dual element. Single element comprises 8 AWG wires in single-hole or two-hole ceramic insulators, or 14 AWG wires in two-hole insulators. Dual element is available as 14 AWG wires only, in one-piece four-hole ceramic insulators, or as two separate elements, each in two-hole insulators.

THERMOCOUPLE JUNCTIONS

The thermocouple junctions are ungrounded since the ceramic protection tube acts as a insulator. When dual junctions are ungrounded, they are insulated from each other as well as the bottom of the tube.

HEAD ASSEMBLIES

Universal Heads are available in either aluminum or cast-iron construction, with single- or dual-element terminal connectors.

Aluminum: Compact, lightweight, weathertight housing has highly polished, corrosion-resistant cap and base, joined by a beaded chain. By compressing a high-temperature silicone-rubber gasket, the cap is quickly and easily secured to the body . . . a quarter turn locks or releases it. Slots across the cap permit applying leverage, simplifying its removal even when hot. The thermocouple opening is tapped ¼″, ½″, ¾″ or 1″ NPT, depending upon the size of the protection tube; the conduit opening is tapped ½″ NPT. (To convert to ¾″ NPT, an adapter can be ordered as an option.)

Cast-Iron: Sturdy cast-iron head features rugged construction for long life in heavy industrial applications. A heat- and-moistureproof gasket forms a watertight seal between the threaded cap-to-base connection. Cap—secured by a heavy chain—has slots to permit leverage. Thermocouple opening is tapped ¼″, ½″, ¾″ or 1″ NPT; conduit opening is tapped ¾″ NPT. (To convert to ½″ NPT, a reducer can be ordered as an option.)

PROTECTION TUBES

L&N Fyrestan (high-grade mullite) and high-purity alumina are used as primary and secondary protection tubes. Alumina is impervious to gases and usable at temperatures as high as 3100 F; Fyrestan, to 2800 F. To prevent breakage due to thermal shock, both alumina and Fyrestan tubes must be preheated at the rate of 200 degrees F per hour up to 800 F.

L&N Fyrestan tubes, equipped with a metal sleeve for mounting a Universal Head, can be used whenever desirable in place of tubes of nickel and chromium alloy. Although not as strong as an alloy, Fyrestan is fully as gas-tight. In some applications, in the range of 1800 to 2000 F, Fyrestan outlasts alloys.

LT-1 metal-ceramic tubes (77% chromium, 23% aluminum oxide) are dense and corrosion-resistant, usable to about 2600 F in most atmospheres. To prevent breakage due to thermal shock, they should be preheated to a temperature of 900 F.

CALIBRATION DATA OPTION

Correction data can be supplied for any temperature point(s) between −100 and 2300 F. Data is provided on a linen tag, wired to the element or assembly . . . can also be provided in a typed report.

HOW TO ORDER

The catalog numbering system simplifies ordering; (a) a complete assembly—element, head, protection tube; (b) a replacement element; or (c) a replacement protection tube. (Any of these can be ordered tagged for temporary or permanent identification.)

In sequence, the catalog number comprises: The base number, 3072 to define a thermocouple element in a ceramic protection tube.

Suffix A, B & E to describe the element. Thermocouple type and element length.

Suffix C to specify the head termination, if any.

Suffix D, E & F to define the protection tube, length and mounting fitting if required.

Suffix G to define the length below designated mounting fitting if specified.

Suffix H to specify any options: Calibration, flange or tagging.

EXAMPLES:

3072-2-K-2-7-24-5-20-206

Specifies a 8GA Type K thermocouple with a cast iron universal head (3072-2-K-2) mounted in a metal ceramic tube (7) 24″ long (24), with a 1¼″ NPT steel bushing (5) mounted on the cermet tube 20″ from the hot end (20). A linen tag (206) is also included wired to the assembly (specify legend).

Replacement Element: 3072-2-K-0-0-24-0-0

Replacement Tube: 3072-0-0-0-7-24-5-20

CAUTION: Temperature limits are governed by the wire gauge and type thermocouple selected (see page B-☐)

Mounting To facilitate mounting, assemblies can be specified with an integral ¾″ NPT mounting bushing (Fig. ☐), an adjustable flange which clamps to an Inconel sleeve, or steel bushings (1¼, 1½ NPT) welded to an Inconel sleeve cemented to a ceramic tube.

A B C D E F G H
Assembly Catalog Number: **3072- ☐ - ☐ - ☐ - ☐ - ☐☐ - ☐ - ☐☐ - ☐☐☐**

A B C D E F G H
Replacement Element: **3072- ☐ - ☐ - 0 - 0 - ☐☐ - 0 - 0 - ☐☐☐**

A B C D E F G H
Replacement Tube: **3072- 0 - 0 - 0 - ☐ - ☐☐ - ☐ - ☐☐ - ☐☐☐**

	Description		Suffix
Suffix A: Element Construction	Single Element	8 AWG Wires in Single Hole Ceramic Insulators (For Tube Options 5 & 6 Only)	1
		8 AWG Wires in 2-Hole Ceramic Insulators (For Tube Options 5, 6, 7 Only)	2
		14 AWG Wires in 2-Hole Ceramic Insulators	3
	Dual Element	14 AWG Wires Supplied As Two Separate Elements Each With 2-Hole Insulators (For Tube Options 5 & 6 Only)	4
		14 AWG Wires in 4-Hole Ceramic Insulators	5
		8 AWG Wires Supplied As Two Separate Elements, Each With 2-Hole Ceramic Insulators (For Tube Option 6 Only)	6
		8 AWG Wires in 4-Hole Ceramic Insulators (For Tube Options 5 & 6 Only)	7
Suffix B: Thermocouple Type (See Table, Page B-4, for Temperature Limits vs Wire Gauge)	Single Element	Nickel, Chromium-Constantan Iron-Constantan Nickel, Chromium-Nickel, Aluminum Nicrosil-Nisil	E J K N
	Dual Element	Nickel, Chromium-Constantan Iron-Constantan Nickel, Chromium-Nickel, Aluminum Nicrosil-Nisil	EE JJ KK NN
Suffix C: Head Assembly	None (Specified When Ordering Replacement Element Only) Aluminum Head, Twist Cap (Tapped for ½" NPT Conduit) Cast Iron Head, Screw Cap (Tapped for ¾" NPT Conduit)		0 1 2
Suffix D: Protection Tube Size and Material	None (Specified When Ordering Replacement Element Only)		0
	L&N Fyrestan	7/16 ID × 11/16 OD With 6 Inch Inconel Sleeve 7/16 ID × 11/16 OD With ¾" NPT Stainless Steel Mounting Bushing ¾ ID × 1 OD With 3" Steel Sleeve (1" NPT Process Connection) 1 ID × 1¼ OD With 3¼" Steel Sleeve (1¼" NPT Process Connection)	1 3 5 6
	High Purity Alumina	7/16 ID × 11/16 OD With 6 Inch Inconel Sleeve 7/16 ID × 11/16 OD With ¾" NPT Stainless Steel Mounting Bushing	2 4
	LT-I Metal-Ceramic (77% Cr, 23% AlO)	⅝ ID With ¾" NPT Conduit Thread Available in Lengths of 12, 18, 24, 30, 36 Only—No Immediate Lengths.	7
Suffix E: Element Length	Nominal Thermocouple Length, in Inches (Minimum, 12"; Maximum, 36"). See Appropriate Figure.		☐☐
Suffix F: Mounting Fitting	None 6" Inconel Sleeve With ¾" NPT Mounting Connection Sleeve Cemented to Ceramic Tube (Fig. 2) Tube Options 1 & 2 Only.		0 1
	6" Inconel Sleeve With 1¼" NPT Steel Bushing Welded to It. Sleeve Cemented to Ceramic Tube (Fig. 3) Tube Options 1 & 2 Only.		2
	6" Inconel Sleeve With 1½" NPT Steel Bushing Welded to It. Sleeve Cemented to Ceramic Tube (Fig. 3) Tube Options 1 & 2 Only.		3
	3" Inconel Sleeve With 1" NPT Mounting Connection. Sleeve Cemented to Ceramic Tube (Fig. 9) Tube Option 7 Only.		4
	3" Inconel Sleeve With 1¼" NPT Steel Bushing Welded to It. Sleeve Cemented to Ceramic Tube (Fig. 10) Tube Option 7 Only.		5
	3" Inconel Sleeve With 1½" NPT Steel Bushing Welded to It. Sleeve Cemented to Ceramic Tube (Fig. 10) Tube Option 7 Only.		6
Suffix G Length Below Mounting Fitting	None Length as Specified—Applicable to Suffix F Options 4, 5, 6 Only		00 ☐☐

	Description			Suffix
Suffix H Options	None			000
	Universal-Head Conduit Adapter	Converts Aluminum Head ½" NPT Conduit Opening for ¾" NPT Conduit Converts Cast-Iron Head ¾" NPT Conduit Opening for ½" NPT Conduit		130 131
	Grounding Connection	Ground Screw Provided Inside Aluminum or Cast-Iron Universal Head for Drain Wire in Conduit Cable		150
	Tagging	1 Linen Tag (Specify Legend) 1 Aluminum Tag, Machine-Stamped, 15 Characters Max. (Specify Legend) 1 Stainless Steel Tag, Electro-Etched, 22 Characters Max. on Each of Three Lines (Specify Legend)		206 207 208
	Calibration	Calibration Check(s): Correction Data Supplied for any Specified Point(s) Between 100 and 2300 F. (Minimum Element Length, 24".) Correction Data Supplied on Linen Tag Correction Data Supplied in Typed Report, plus Linen Tag		300 301
	Adjustable Flange	Clamps to Inconel Sleeve of Primary Tube	Cast-Iron Flange With Locking Screw, 3¼" OD	400
		Clamps to Metal Sleeve on Ceramic Tube.	Malleable Iron Flange, 4" OD, Threaded on 1¼" STD Pipe 5½" Long, with Locking Screw. (Fig. 6)	402
			Malleable Iron Flange, 4½" OD, Threaded on 1½" STD Steel Pipe 5³⁄₁₆" Long with Locking Screw (Fig. 7)	403

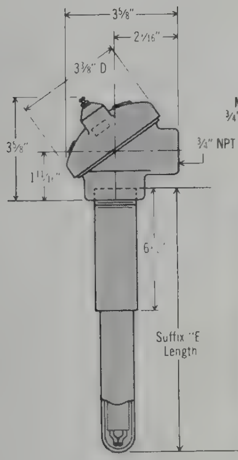

3⅝"
2⁷⁄₁₆"
3⅜" D
3⅝"
1¹¹⁄₁₆"
¾" NPT
6"
Suffix "E
Length

Figure 1

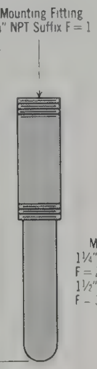

Mounting Fitting
¾" NPT Suffix F = 1

Figure 2

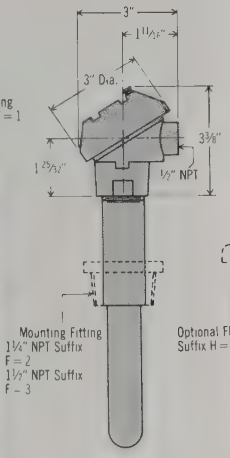

3"
1¹¹⁄₁₆"
3" Dia.
3⅜"
1²⁵⁄₃₂"
½" NPT
Mounting Fitting
1¼" NPT Suffix
F = 2
1½" NPT Suffix
F – 3

Figure 3

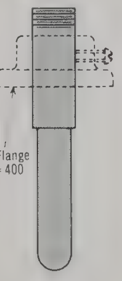

Optional Flange
Suffix H = 400

Figure 4

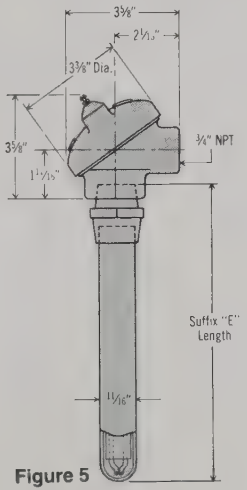

3⅝"
2⁷⁄₁₆"
3⅜" Dia.
3⅝"
1¹¹⁄₁₆"
¾" NPT
Suffix "E"
Length
¹¹⁄₁₆"

Figure 5

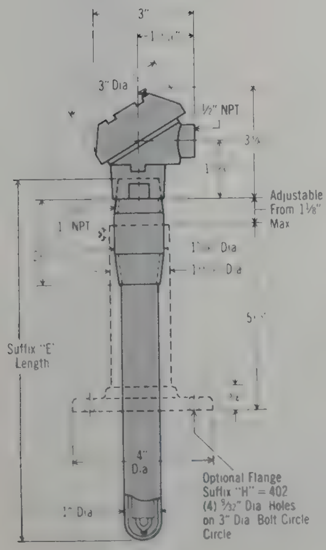

3"
3" Dia
½" NPT
Adjustable
From 1⅛"
Max
1 NPT
Suffix "E"
Length
4"
Dia
1" Dia
Optional Flange
Suffix "H" = 402
(4) ⁵⁄₃₂" Dia Holes
on 3" Dia Bolt Circle
Circle

Figure 6

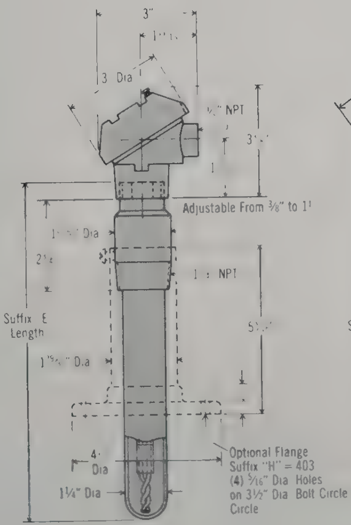

3"
3 Dia
NPT
Adjustable From ⅜" to 1"
Dia
NPT
Suffix E
Length
Dia
4
Dia
1¼" Dia
Optional Flange
Suffix "H" = 403
(4) ⁵⁄₁₆" Dia Holes
on 3½" Dia Bolt Circle
Circle

Figure 7

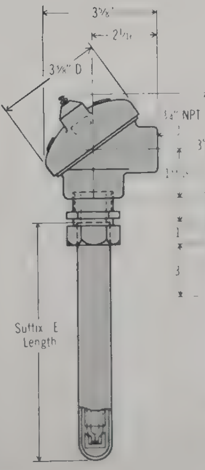

3⅝"
3⅜" D
NPT
Suffix E
Length

Figure 8

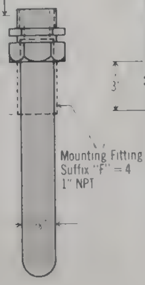

Mounting Fitting
Suffix "F" = 4
1" NPT

Figure 9

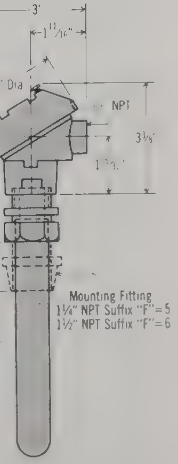

3"
1¹¹⁄₁₆"
3" Dia
NPT
3⅜"
Mounting Fitting
1¼" NPT Suffix "F" = 5
1½" NPT Suffix "F" = 6

Figure 10

3050-Series in Thermowells

- **For thermocouple measurements in high-pressure environments: chemical, petrochemical, power plants, etc.**
- **Multiple well-types: standard or heavy-duty threaded, socket-weld design, weld-in design, or flange-type**
- **Single- or dual-element construction**
- **Spring-loaded elements optional, for fast response and/or protection against vibration**
- **Nipple-union-nipple connections between head and well available to facilitate installation, servicing**
- **Ordering complete assemblies or separate components simplified by catalog numbering**

Thermocouple assemblies with thermowells are used principally in applications where it is desirable to measure temperatures in a high-pressure environment and/or where there is severe vibration, such as those encountered in chemical and petrochemical applications, and in water, steam and air lines in power-plant installations.

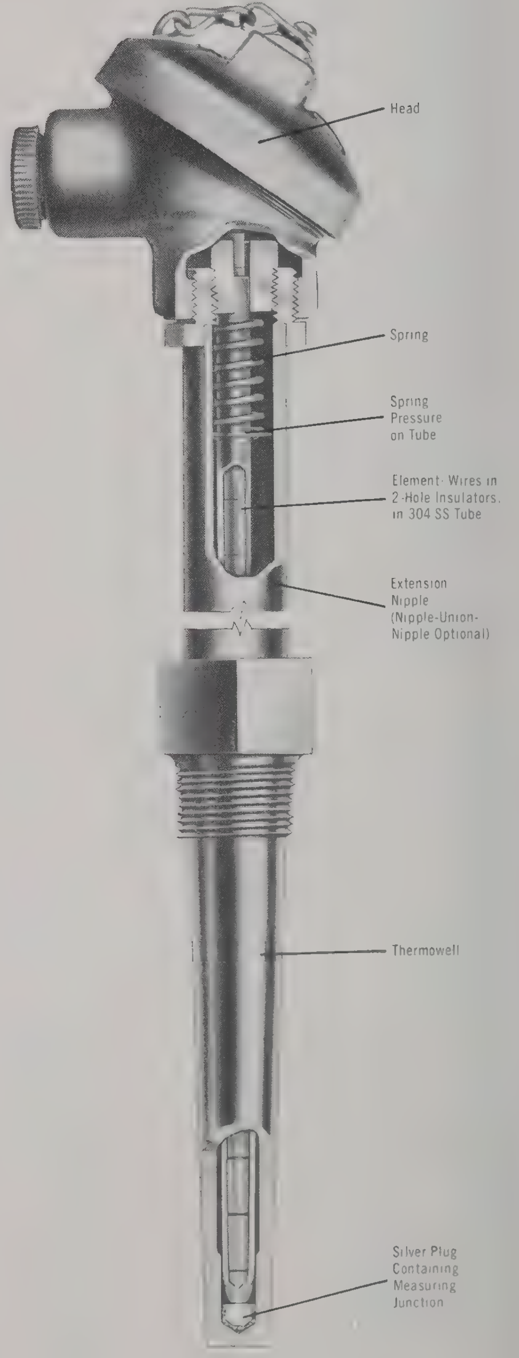
Leeds & Northrup offers a broad selection of base-metal thermocouples and thermowells, specified by a catalog-numbering system which offers maximum flexibility in ordering (1) a complete assembly with thermowell, (2) an element assembly and a compatible thermowell as separate items, to simplify installation, or (3) replacement elements only.

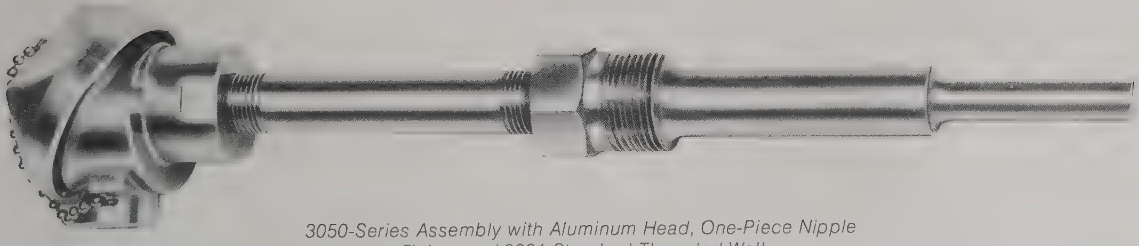
SPRING-LOADING

Elements and assemblies are available with or without spring-loading. Spring-loading assures fast response for control applications, and helps protect against the mechanical effects of severe vibration.

Spring-loaded elements comprise wires with insulators, encased in a stainless-steel tube, or wires in compacted-ceramic insulation in a stainless-steel sheath. A unique spring-loading design permits optimum spring compression. A retaining ring is brazed to tube or sheath close to the head end; a spring is compressed between the ring and a bushing assembly, forcing the thermocouple junction into contact with the tip of the well.

The grounded junction required for spring-loading terminates in a silver plug. Use of this plug, and a special technique to seat it in the well cavity, result in excellent response to temperature change . . . a time constant of approximately 12 seconds, including 3.5 seconds for initial response.


Head
Spring
Spring Pressure on Tube
Element Wires in 2-Hole Insulators, in 304 SS Tube
Extension Nipple (Nipple-Union-Nipple Optional)
Thermowell
Silver Plug Containing Measuring Junction



3050-Series Assembly with Aluminum Head, One-Piece Nipple Fitting, and 3201 Standard Threaded Well

3050-Series Assembly with Cast-Iron Head, Spring-Loaded Element with Nipple-Union-Nipple Fitting, and 3203 or 3213 Heavy-Duty Threaded Well

ELEMENTS

Type: Elements are available in three types: (1) 14 or 20 AWG wires with insulators, with a welded exposed junction for non-spring-loading; (2) 14 or 16 AWG wires with insulators in a 304 SS tube, with junction grounded in a silver plug and a retaining ring brazed to the tube for spring-loading; or (3) 16 or 18 AWG wires with compacted-ceramic insulation in a 304 SS sheath, with retaining ring; usable for spring-loading or non-spring-loading.

Thermocouple: Single- or dual-element thermocouples are available—nickel, chromium-constantan (Type E), iron-constantan (Type J), nickel, chromium-nickel, aluminum (Type K), copper-constantan (Type T), or Nicrosil-Nisil (Type N).

Junction: Junctions can be ungrounded, or grounded to the tip of the thermowell (spring-loaded assemblies with silver plug *must* be grounded); dual-element junctions can also be insulated from each other and from the sheath or thermowell.

Length: Length of an element is specified in inches. For a complete assembly, or a replacement for an L&N assembly with a standard well, the overall element length is the insertion length of the thermowell (Dimension "U" in the thermowell drawings) plus an allowance for the nipple, lagging extension, etc. (see Suffix D). An additional 4 inches of thermocouple wire for terminal connections, with ISA color-coded sleeving, is provided at the head end of the element.

Calibration Checks: As an option, a thermocouple can be checked at one or more points between – 100 and 2300 F, depending upon wire type, gauge and insulation. Correction data is supplied on a linen tag wired to the element or assembly; correction data can also be provided in a typed report. Minimum element length must be 24".

ASSEMBLY WITHOUT THERMOWELL

An assembly without thermowell includes an Element (as described above), Head and Mounting Fitting.

Head: Heads are available with (1) terminal blocks for single- or dual-element connections, (2) thermocouple openings tapped for non-spring-loading or spring-loading applications, and (3) aluminum or cast-iron construction.

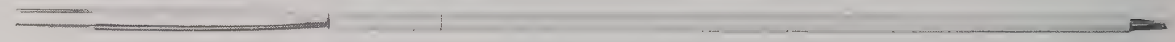
Heads for non-spring-loading are tapped with either a ½" or ¾" NPT opening to accept the Mounting Fitting. For spring-loading applications, the Head is tapped with a 1" NPT opening to accept the bushing silver-soldered on the Mounting Fitting.

Cast-iron heads have a screw cap, and a conduit opening tapped for ¾" NPT. Aluminum heads have a twist cap and are tapped for ½" NPT at the conduit opening. Optional adapters, to convert a ¾" NPT conduit opening to ½" NPT, or vice versa, are available

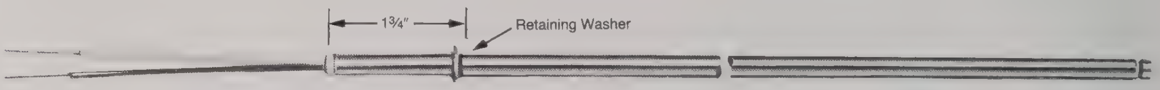
Mounting Fitting: Mounting Fittings, which connect the head to the thermowell, are either one-piece nipple-type, or a nipple-union-nipple combination; length between head and well (exclusive of threads) is 6 inches.

At the head end, the nipples have either ½" NPT or ¾" NPT threads for non-spring-loading assemblies, or a 1" NPT bushing silver-soldered to the nipple for spring-loading. At the well end, the nipples terminate in either ½" NPT or ¾" threads.

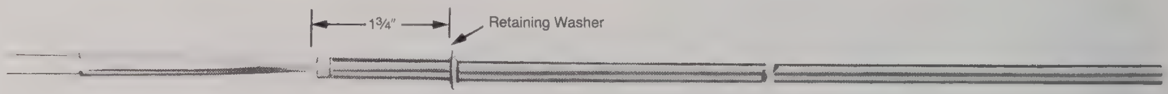
Use of the nipple-union-nipple combination is recommended for spring-loaded assemblies, or where high temperatures make it impractical to service or replace an element at the point of installation. The union can be quickly disconnected, and the head, upper nipple and internal element can be removed intact to a location more suitable for servicing.



Element Only: Wires with Insulators, Welded Exposed Junction, for Non-Spring-Loading (Suffix A=1)



Element Only: Wires with Insulators in 304 SS Tube, Junction Grounded in Silver Plug, for Spring-Loading (Suffix A=2)



Element Only: Wires with Compacted Ceramic Insulation in 304 SS Sheath, for Spring-Loading or Non-Spring-Loading (Suffix A=3)

Connections: As described above, connections between nipple and head (except for spring-loaded assemblies) and between nipple and well are either ½″ NPT or ¾″ NPT.

While ½″ NPT is the SAMA standard, Leeds & Northrup practice (long antedating the standard) has been to recommend the stronger ¾″ NPT connections. To assure optimum flexibility of choice, however, we offer all thermowells and thermowell assemblies with either size connection.

THERMOWELLS

Type: All wells are available as either 3200-Series, with a 0.260″ bore to accept 3050-Series elements, or as 3210-Series, with a 0.385″ bore for 3051-Series elements. Configurations include standard (straight) and heavy-duty (tapered) wells for thread-mounting, with or without a 3″ lagging extension; socket-weld-design (straight) or weld-in (tapered) wells; and flanged (straight) wells. Appropriate drawings are provided on pages 24 and 25.

Material: A wide choice of materials is available for all well types. Selection of material is governed by insertion length, temperature, pressure and flow factors, as well as the medium. L&N will be glad to make suggestions based on the A.S.M.E. Boiler Code, Section VIII.

A high mirror polish is given to all stainless steel and Monel wells to provide good corrosion resistance on the surface exposed to the process medium. Wells of 347 stainless steel are heat-treated and passivated to increase their resistance to corrosion. This treatment is also available on special order for 304 and 316 stainless steel wells, and for F-11 and F-22 alloys.

Insertion Length: Insertion length is determined by the temperature, pressure and flow of the measured medium (for details, see tables on the next page). Eight standard lengths from 2½″ to 22½″ are available; non-standard lengths can be specified

Internal Thread: The internal thread, to accept the nipple of the Mounting Fitting, may be ½″ NPT or ¾″ NPT.

Mounting Connection: The mounting connection (well to pipe or process vessel) can be: (1) threaded, for standard or heavy-duty wells; (2) welded, for socket-weld-design or weld-in-design wells; or (3) flange-type. See thermowell illustrations for details.

HOW TO ORDER

The catalog number system permits ordering (a) a complete assembly, including thermowell; (b) an element assembly with head and nipple only, for use with a separate well; (c) a well only; or (d) a replacement element only. (Any of these can be ordered tagged for temporary or permanent identification.) Where it is desirable to mount the thermowell first, and install the element, head and nipple later, the complete assembly can be ordered as two separate components, (b) and (c).

In sequence, the catalog number comprises:
a base number (3050 or 3051) followed by Suffixes A to D to define the Element;
Suffixes E, F and G to define a Head and Mounting Fitting;
a base number for a thermowell (3200-Series or 3210-Series) followed by *its* Suffixes Ha to Hd; and
a tagging-option and/or calibration suffix.

EXAMPLES

3050-3-EE-1-12.25-0-6-3-3203-2-2-1-1-0-0-207
Specifies a complete assembly comprising 18 AWG wires with compacted ceramic insulation **(3050-3)**, dual-element nickel, chromium-constantan **(EE)**, grounded junction **(1)**, 12¼″ element length **(12.25)**, dual-element cast-iron head for spring-loading **(0-6)**, nipple-union-nipple, ½″ NPT at well end **(3)**, with heavy-duty threaded well, 0.260″ bore **(3203)**, 304 stainless steel **(2)**, 4½″ insertion length **(2)**, ½″ NPT internal thread for nipple **(1)**, ¾″ NPT thread for mounting **(1)**, no flange **(0-0)**, aluminum tag option **(207)**.

Element Assembly Without Well: 3050-3-EE-1-12.25-0-6-3-0-207.

Thermowell: 3203-2-2-1-1-0-0-000.

Replacement Element: 3050-3-EE-1-12.25-0-0-0-0-000.

THERMOWELL PRESSURE/TEMPERATURE/VELOCITY RATINGS

MAXIMUM PRESSURE, PSI

3201, 3202, 3205, 3211, 3212, 3213, 3214, 3215 Thermowells: PSI Pressure/Temperature Rating*

Material	TEMPERATURE — °F						
	70	200	400°	600°	800	1000°	1200°
Carbon Steel	5200	5000	4800	4600	3500	1500	—
304, 347	7000	6200	5600	5400	5200	4500	1650
316	7000	7000	6400	6200	6100	5100	2500
Monel	6500	6000	5400	5300	5200	1500	—

3203 & 3204 Thermowells: PSI Pressure/Temperature Rating*

Material	TEMPERATURE — °F						
	70°	200°	400	600	800	1000	1200
Carbon Steel	5950	5750	5450	5250	4000	1750	—
304, 347	7800	7050	6400	6150	6000	5190	1875
316	7800	7800	7250	7100	6950	5800	2720
Monel	7450	6850	6150	6100	5940	1750	—

3207 & 3217 THERMOWELLS (Figure J)

PSI Maximum Flange Pressure-Temperature Rating

Carbon Steel: To 2500 psi, up to 800 F.
AISI 304: To 2500 psi, up to 1000 F.
AISI 316: To 2500 psi, up to 1125 F.

MAXIMUM FLUID VELOCITY, FPS**

Well and Material	INSERTION LENGTH — "U"							
	2½	4½	7½	10½	13½	16½	19½	22½
3201, 3202, ½" NPT:								
Carbon Steel	290 (106)	105 (59)	38.2 (36.3)	19.4	11.8	7.8	5.7	4.2
304, 316, 347	300 (148)	109 (82.2)	39.5	20.1	12.2	8.1	5.9	4.4
R-Monel	261 (118)	95 (65 5)	34.4	17.5	10.5	7.1	5.2	3.8
3201, 3202, ¾" NPT:								
Carbon Steel	290 (106)	123 (71 2)	44.9 (42.7)	22.8	13.8	9.3	6.7	4.9
304, 316, 347	300 (148)	128 (99.3)	46.4	23.6	14.3	9.6	6.9	5.1
R-Monel	261 (118)	112 (79.8)	40.6	20.7	12.4	8.3	6.1	4.5
3201, 3202, 1" NPT:								
Carbon Steel	290 (106)	143 (84.3)	51.6 (50 6)	26.2	15.9	10.6	7.6	5.7
304, 316, 347	300 (148)	148 (117)	53.5	27.2	16.5	11.0	7.9	5.9
R-Monel	261 (118)	128 (93.3)	46.7	23.7	14.4	9.5	6.9	5.1
3203, 3204, ¾" NPT:								
Carbon Steel	386 (175)	180 (97 2)	65.3 (58 3)	33.0	20.1	13.4	9.6	7.1
A.I.S.I. 304, 316, 347	440 (243)	197 (135)	71.2	36.0	22.0	14.7	10.5	7.8
R-Monel	354 (195)	155 (108)	56.1	28.4	17.3	11.6	7.5	5.6
3203, 3204, 1" NPT:								
Carbon Steel	448 (289)	209 (161)	75.7	38.4	23.3	15.5	11.1	8.2
A.I.S.I. 304, 316, 347	490 (403)	228 (225)	82.5	41.8	25.5	17.1	12.2	9.1
R-Monel	410 (322)	179 (178)	65.1	33.0	20.1	13.5	8.7	6.5
3205, ¾" IPS:								
Carbon Steel	290 (106)	123 (71 2)	44.9 (42 7)	22.8	13.8	9.3	—	4.9
A.I.S.I. 304, 316, 347	300 (148)	128 (99.3)	46.4	23.6	14.3	9.6	—	5.1

Well and Material	INSERTION LENGTH — "U"							
	2½	4½	7½	10½	13½	16½	19½	22½
3205, 1" IPS:								
Carbon Steel	290 (106)	143 (84.3)	51.6 (50.6)	26.2	15.9	10.6	—	5.7
A.I.S.I. 304, 316, 347	300 (148)	148 (117)	53.5	27.2	16.5	11.0	—	5.9
3207								
Carbon Steel	404 (129)	184 (71.2)	67 0 (42.7)	34.0	20.6	13.7	—	7.4
A.I.S.I. 304, 316, 347	430 (179)	192 (99.3)	69.7 (59.6)	35.4	21.5	14.3	—	7.7
R-Monel	350 (143)	168 (79.8)	61 (47.7)	31.0	18.8	12.5	—	6.7
3211, 3212								
Carbon Steel	326 (260)	192 (144)	69.5	35.4	20.5	14.3	10.3	7.7
A.I.S.I. 304, 316, 347	349 (260)	199	71.9	36.6	21.2	14.8	10 7	8.0
R-Monel	316 (220)	189 (178)	68.1	34.8	20.8	14.0	10.0	7.5
3213, 3214								
Carbon Steel	410 (270)	249 (150)	90 3	45.6	27.8	18.5	13.2	9.8
A.I.S.I. 304, 316, 347	483 (350)	272 (208)	97.3	49.7	30.4	20.3	14.5	10 7
R-Monel	396 (300)	214 (167)	77.5	39.2	23.8	16.0	10.3	7.7
3215, ¾" & 1" IPS:								
Carbon Steel	426 (260)	192 (144)	69.5	35.4	20 5	14.3	—	7.7
A.I.S.I 304, 316, 347	449 (360)	199	71.9	36.6	21.2	14 8	—	8.0
3217:								
Carbon Steel	410 (152)	248 (84.3)	91.3 (50 6)	45.7	27.6	18.5	—	10.0
A.I.S.I. 304, 316, 347	444 (211)	258 (117)	95.2 (70.3)	47.6	28 8	19.3	—	10.4
R-Monel	338 (168)	226 (93.3)	83.3 (56.0)	41.6	25.2	16 9	—	9.1

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*Values are based on allowable stress levels published in the A S M E Boiler Code, Section VIII

**Ratings are based on operating temperatures of 1000 F for Car[illegible] and 347, 900 F for Monel. Where a single value appears in t[illegible] considered safe fo[illegible] parenthesis repre[illegible] be used for steam, air, gas and similar-density fluids

A B C D E F G H J

Assembly Catalog Number: **305☐–☐–☐–☐–☐☐.☐☐–☐–☐–☐–☐–☐☐☐**

	Description					Suffix
Base Number and Suffix A: Type of Element	Wires with Insulators, Welded Exposed Junction, **No Spring-Loading**	20 AWG (0.15" OD)				3050-1
		14 AWG (¼" × 9/32" OD)				3051-1
	Wires with Insulators in 304 SS Tube, Junction Grounded in Silver Plug. **Spring-Loading Only**	16 AWG Wire, Single Element 0.235" OD Tube				3050-2
		14 AWG Wire, 0.343" OD Tube				3051-2
	Wires with Compacted Ceramic (Magnesium Oxide) Insulation in 304 SS Sheath. **For Spring-Loading or Non-Spring-Loading**	18 AWG Wire, 0.250" OD Sheath				3050-3
		16 AWG Wire, 0.313" OD Sheath				3051-3
Suffix B: Type of Thermocouple (See Table, Page B-4 for Temperature Limits vs Wire Gauge)	Single Element	Nickel, Chromium-Constantan				E*
		Iron-Constantan				J
		Nickel, Chromium-Nickel, Aluminum				K
		Copper-Constantan				T
		Nicrosil-Nisil				N
	Dual Element	Nickel, Chromium-Constantan				EE*
		Iron-Constantan				JJ
		Nickel, Chromium-Nickel, Aluminum				KK
		Copper-Constantan				TT
		Nicrosil-Nisil				NN
Suffix C: Type of Junction	Grounded to Tip of Sheath or Thermowell (Single Element or Common-Junction Dual Element)					1
	Ungrounded: Does not Touch Tip of Sheath or Thermowell (Single Element or Common-Junction Dual Element)					2
	Isolated and Insulated from Each Other and from Sheath or Thermowell					3
Suffix D: Nominal Element Length**	Length in Inches, to Two Decimal Places, of Thermowell Insertion Length (Dimension "U") **plus:** 7.75" for Threaded Wells without Lagging Extension (3201, 3211, 3203, 3213) and for Socket-Weld-Design Wells (3205, 3215) 10.75" for Wells with Lagging Extension (3202, 3212, 3204, 3214) 9" for Weld-In Wells (3206, 3216) 8.25" for Flanged Wells (3207, 3217)					
Suffix E-F: Head Assembly	None					0-0
	Single Element	Aluminum, Twist Cap	Non-Spring-Loading	½" NPT Conduit, ½" NPT Thermocouple		1-0
				½" NPT Conduit, ¾" NPT Thermocouple		2-0
			Spring-Loading	½" NPT Conduit, 1" NPT Thermocouple		3-0
		Cast Iron, Screw Cap	Non-Spring-Loading	¾" NPT Conduit, ½" NPT Thermocouple		4-0
				¾" NPT Conduit, ¾" NPT Thermocouple		5-0
			Spring-Loading	¾" NPT Conduit, 1" NPT Thermocouple		6-0
	Dual Element	Aluminum, Twist Cap	Non-Spring-Loading	½" NPT Conduit, ½" NPT Thermocouple		0-1
				½" NPT Conduit, ¾" NPT Thermocouple		0-2
			Spring-Loading	½" NPT Conduit, 1" NPT Thermocouple		0-3
		Cast Iron Screw Cap	Non-Spring-Loading	¾" NPT Conduit, ½" NPT Thermocouple		0-4
				¾" NPT Conduit, ¾" NPT Thermocouple		0-5
			Spring-Loading	¾" NPT Conduit, 1" NPT Thermocouple		0-6
Suffix G: Mounting Fitting	None					0
	6" Standard Length	Spring-Loading	1" Bushing Silver-Soldered to Head End	Nipple-Type: 304 SS	½" NPT at Well End	1
					¾" NPT at Well End	2
				Nipple-Union-Nipple: 304 SS	½" NPT at Well End	3
					¾" NPT at Well End	4
		Non-Spring-Loading	Nipple-Type: 304 SS		½" NPT, Both Ends	5
					¾" NPT, Both Ends	6
			Nipple-Union-Nipple: 304 SS		½" NPT, Both Ends	7
					¾" NPT, Both Ends	8
	Non-Standard Length: Specify Length, Engaged (3", Minimum)	Spring-Loading	Nipple-Type: 304 SS: 1" Bushing Silver-Soldered to Head End		½" NPT at Well End	91
					¾" NPT at Well End	92
		Non-Spring-Loading	Nipple-Type: 304 SS		½" NPT, Both Ends	95
					¾" NPT, Both Ends	96

**For premium-grade accuracy, see Suffix J, Option 310; applicable to 3050-3 and 3051-3 only*

***Dimensions are based on 6" standard Mounting Fitting (Suffix G). For shorter or longer Fitting, decrease or increase Element Length proportionately.*

		Description	Suffix
Suffix J: Options	None		000
	Tagging	1 Linen Tag (Specify Legend)	206
		1 Aluminum Tag, Machine-Stamped, 15 Characters Max. (Specify Legend)	207
		1 Stainless-Steel Tag, Electro-Etched, 22 Characters Max. on Each of Three Lines (Specify Legend)	208
	Calibration	Calibration Check(s): Correction Data Supplied for Any Specified Point(s) Between –100 and 2100 F. (Minimum Element Length, 24".)	
		Correction Data Supplied on Linen Tag	300
		Correction Data Supplied in Typed Report, plus Linen Tag	301
	Universal-Head Conduit Adapter	Converts Aluminum Head ½" NPT Conduit Opening for ¾" NPT Conduit	130
		Converts Cast-Iron Head ¾" NPT Conduit Opening for ½" NPT Conduit	131
	Grounding Connection	Ground Screw Provided Inside Aluminum or Cast-Iron Universal Head for Drain Wire in Conduit Cable	150
	Calibration	Premium-Grade Accuracy Element: Available for Type E or EE, in ¼" or 5/16" dia 304 SS Sheath Only	310
	Plug and Chain	Brass	160
		304 Stainless Steel	170

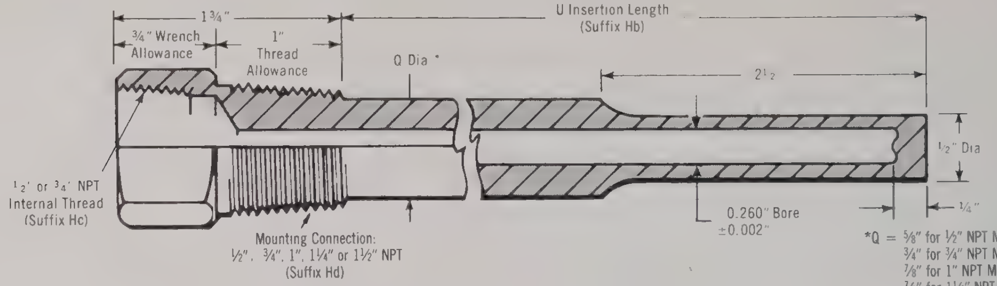
H Ha Hb Hc Hd He Hf

Thermowell Catalog Number: **32☐☐ –☐– ☐ –☐– ☐ –☐– ☐**

	Description		Suffix	
			For 3050-Elements	For 3051-Elements
Base Number, H: Well Design	Standard Threaded Well (Figures A & C)		3201*	3211
	Standard Threaded Well With 3" Lagging Extension (Figures B & D)		3202	3212
	Heavy-Duty Threaded Well, Tapered (Figure E)		3203	3213
	Heavy-Duty Threaded Well, Tapered, With 3" Lagging Extension (Figure F)		3204	3214
	Socket-Weld-Design Well (Figures G & H)		3205	3215
	Weld-In Tapered Well (Figure I)		3206	3216
	Flanged Well (Figure J)		3207	3217
Suffix Ha: Material	Carbon Steel (C1018)		1	
	304 Stainless Steel		2	
	316 Stainless Steel		3	
	347 Stainless Steel (Heat-Treated and Passivated)		4	
	Inconel		5	
	F11 (1¼% Chromium, ½% Molybdenum)		6	
	F22 (2¼% Chromium, 1% Molybdenum)		7	
	R-Monel		8	
	Non-Listed Material (Specify)		9	
Suffix Hb: Insertion Length (Dimension "U")	2½"		1	
	4½"		2	
	7½"		3	
	10½"		4	
	13½"		5	
	16½"		6	
	19½"		7	
	22½"		8	
	Non-Standard Insertion Length (Specify)		9	
Suffix Hc: Internal Thread	½" NPT (For Use with Element Mounting-Fitting Suffix G: 1, 3, 5 or 7)		1	
	¾" NPT (For Use with Element Mounting-Fitting Suffix G: 2, 4, 6 or 8)		2	
Suffix Hd: Mounting Connection	For Standard Threaded Wells: 3201, 3211, 3202 or 3212	½" NPT Thread	1**	
		¾" NPT Thread	2	
		1" NPT Thread	3	
		1¼" NPT Thread	4	
		1½" NPT Thread	5	
	For Heavy-Duty Threaded Wells: 3203, 3213, 3204 or 3214	¾" NPT Thread	1	
		1" NPT Thread	2	
		1¼" NPT Thread	4	
		1½" NPT Thread	5	
	For Socket-Weld-Design Wells: 3205 or 3215	1.050" OD (¾" IPS)	1	
		1.315" OD (1" IPS)	2	
	For Weld-In Wells: 3206 or 3216	1½" OD	1	
		1⅝" OD	2	
	For Flanged Wells: 3207 or 3217		0	
Suffix He: Flange Type	None (Used for Wells Other Than 3207 or 3217)		0	
	1", 150 Lb, Raised Face		1	
	1½", 150 Lb, Raised Face		2	
	Non-Standard (Specify Size, Pressure and Facing)		9	
Suffix Hf: Flange Material	None (Used for Wells Other Than 3207 or 3217)		0	
	Carbon Steel (C1018)		1	
	304 Stainless Steel		2	
	316 Stainless Steel		3	
	Non-Standard (Specify Material)		9	

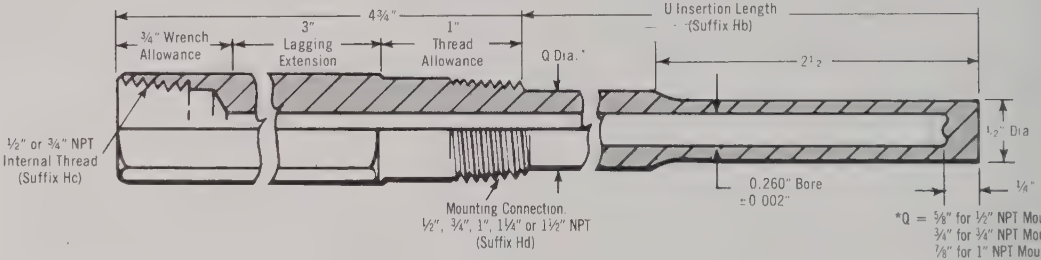
*Stocked wells with insertion length (Dimension "U") of 3½" or 6" can be supplied, specify 3201 1-9-1-1-0-0-900 (3½") or 3201-1-9-1-1-0-0-901 (6

**Suffix Hc-2 (¾" NPT internal pipe thread) cannot be specified with this Suffix Hd option


1¾"
¾" Wrench Allowance
1" Thread Allowance
U Insertion Length (Suffix Hb)
Q Dia *
2½
½" Dia
½" or ¾" NPT Internal Thread (Suffix Hc)
0.260" Bore ±0.002"
¼"
Mounting Connection: ½", ¾", 1", 1¼" or 1½" NPT (Suffix Hd)

*Q = ⅝" for ½" NPT Mounting;
¾" for ¾" NPT Mounting;
⅞" for 1" NPT Mounting;
⅞" for 1¼" NPT Mounting;
⅞" for 1½" NPT Mounting

Figure A. 3201 Standard Threaded Well with 0.260" Bore


4¾"
¾" Wrench Allowance
3" Lagging Extension
1" Thread Allowance
U Insertion Length (Suffix Hb)
Q Dia. *
2½
½" Dia
½" or ¾" NPT Internal Thread (Suffix Hc)
0.260" Bore ±0.002"
¼"
Mounting Connection. ½", ¾", 1", 1¼" or 1½" NPT (Suffix Hd)

*Q = ⅝" for ½" NPT Mounting;
¾" for ¾" NPT Mounting;
⅞" for 1" NPT Mounting;
⅞" for 1¼" NPT Mounting;
⅞" for 1½" NPT Mounting

Figure B. 3202 Standard Threaded Well with Lag Extension and 0.260" Bore

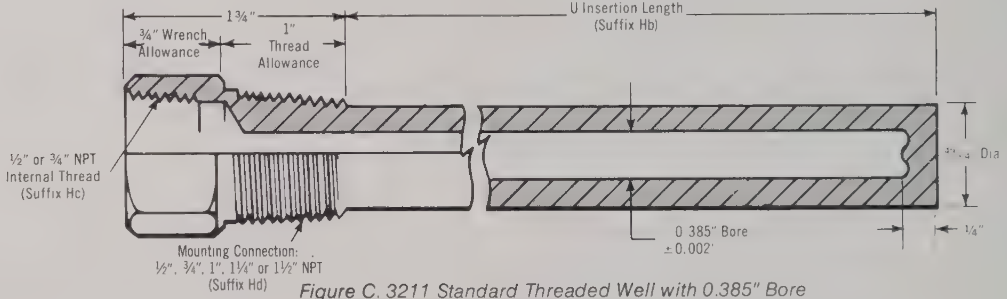

1¾"
¾" Wrench Allowance
1" Thread Allowance
U Insertion Length (Suffix Hb)
49/64" Dia
½" or ¾" NPT Internal Thread (Suffix Hc)
0.385" Bore ±0.002"
¼"
Mounting Connection: ½", ¾", 1", 1¼" or 1½" NPT (Suffix Hd)

Figure C. 3211 Standard Threaded Well with 0.385" Bore

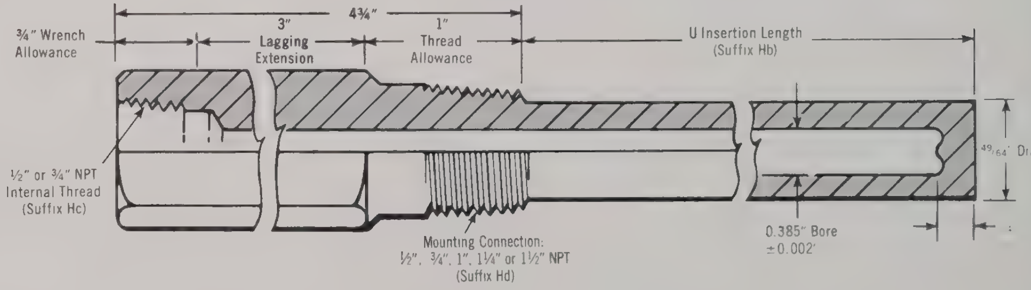
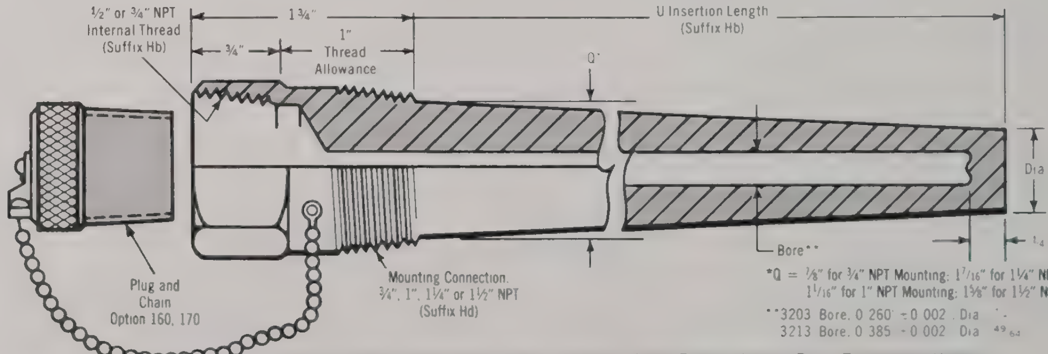

¾" Wrench Allowance
4¾"
3" Lagging Extension
1" Thread Allowance
U Insertion Length (Suffix Hb)
49/64" Dia
½" or ¾" NPT Internal Thread (Suffix Hc)
0.385" Bore ±0.002"
Mounting Connection: ½", ¾", 1", 1¼" or 1½" NPT (Suffix Hd)

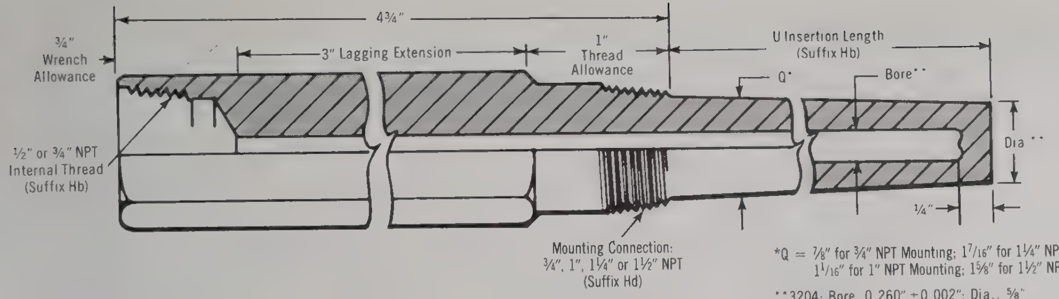
Figure D. 3212 Standard Threaded Well with Lag Extension and 0.385" Bore


½" or ¾" NPT Internal Thread (Suffix Hb)
1¾"
¾"
1" Thread Allowance
U Insertion Length (Suffix Hb)
Q*
Dia **
Bore**
¼
Plug and Chain Option 160, 170
Mounting Connection. ¾", 1", 1¼" or 1½" NPT (Suffix Hd)

*Q = ⅞" for ¾" NPT Mounting; 1⁷⁄₁₆" for 1¼" NPT Mounting;
1¹⁄₁₆" for 1" NPT Mounting; 1⅝" for 1½" NPT Mounting

**3203 Bore, 0.260" ±0.002, Dia ½"
3213 Bore, 0.385" ±0.002, Dia 49/64"

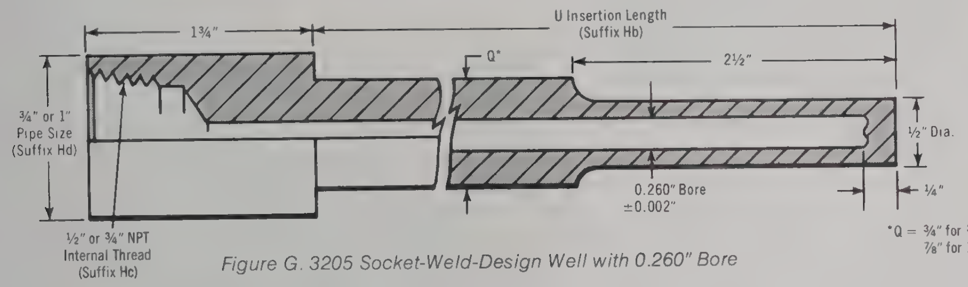
Figure E. 3203 (0.260" Bore) and 3213 (0.385" Bore) Heavy-Duty Threaded Wells


4¾″
¾″ Wrench Allowance
3″ Lagging Extension
1″ Thread Allowance
U Insertion Length (Suffix Hb)
Q*
Bore**
Dia**
½″ or ¾″ NPT Internal Thread (Suffix Hb)
¼″
Mounting Connection: ¾″, 1″, 1¼″ or 1½″ NPT (Suffix Hd)

*Q = ⅞″ for ¾″ NPT Mounting; 1⁷⁄₁₆″ for 1¼″ NPT Mounting; 1¹⁄₁₆″ for 1″ NPT Mounting; 1⅝″ for 1½″ NPT Mounting

**3204: Bore, 0.260″ ±0.002″; Dia., ⅝″
3214: Bore, 0.385″ ±0.002″; Dia., ⁴⁹⁄₆₄″

Figure F. 3204 (0.260″ Bore) and 3214 (0.385″ Bore) Heavy-Duty Threaded Wells with Lag Extension


1¾″
U Insertion Length (Suffix Hb)
Q*
2½″
¾″ or 1″ Pipe Size (Suffix Hd)
½″ Dia.
0.260″ Bore ±0.002″
¼″
½″ or ¾″ NPT Internal Thread (Suffix Hc)

*Q = ¾″ for ¾″ Pipe Size; ⅞″ for 1″ Pipe Size

Figure G. 3205 Socket-Weld-Design Well with 0.260″ Bore

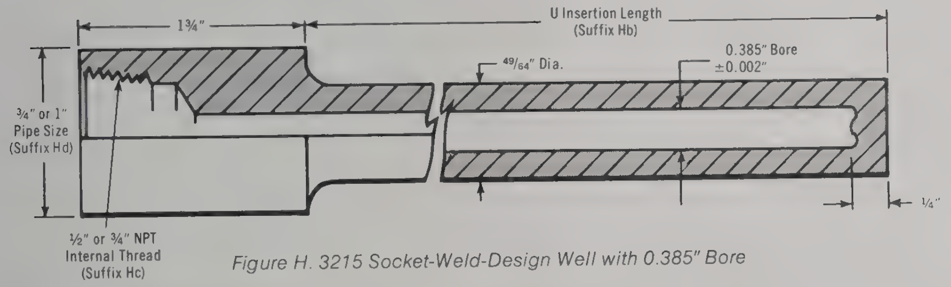
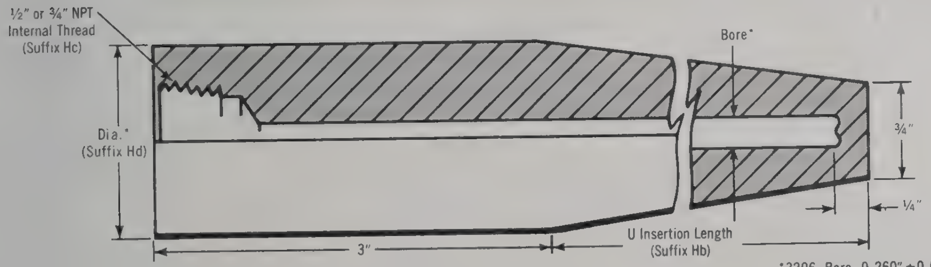
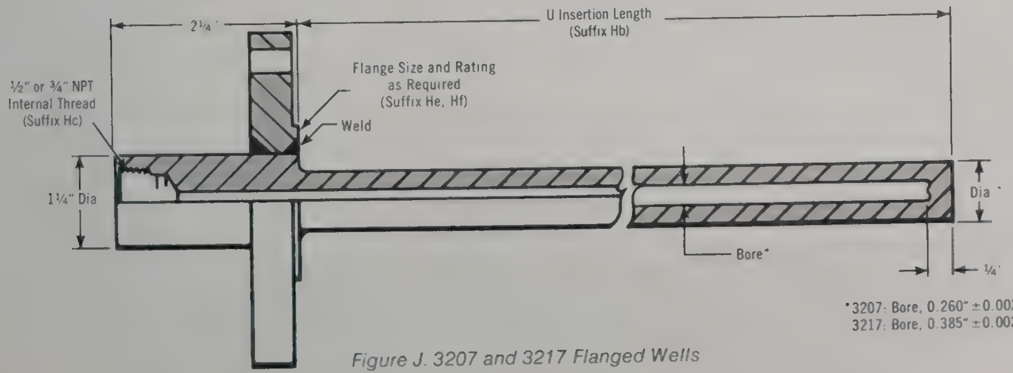

1¾″
U Insertion Length (Suffix Hb)
⁴⁹⁄₆₄″ Dia.
0.385″ Bore ±0.002″
¾″ or 1″ Pipe Size (Suffix Hd)
¼″
½″ or ¾″ NPT Internal Thread (Suffix Hc)

Figure H. 3215 Socket-Weld-Design Well with 0.385″ Bore


½″ or ¾″ NPT Internal Thread (Suffix Hc)
Bore*
Dia.* (Suffix Hd)
¾″
¼″
3″
U Insertion Length (Suffix Hb)

*3206: Bore, 0.260″ ±0.002″; Dia., 1½″ or 1⅝″;
3216: Bore, 0.385″ ±0.002″; Dia., 1½″ or 1⅝″

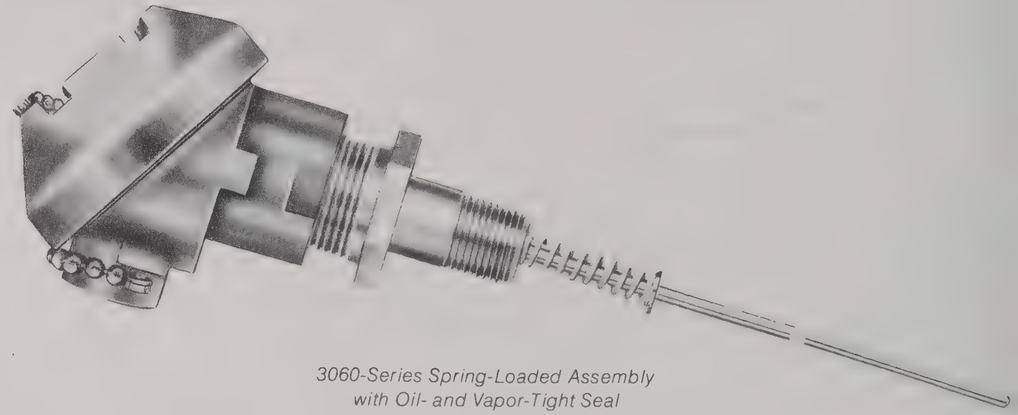
Figure I. 3206 and 3216 Weld-In-Design Wells for Welding Directly into a Pipe or Weld-o-let.


2¼″
U Insertion Length (Suffix Hb)
Flange Size and Rating as Required (Suffix He, Hf)
Weld
½″ or ¾″ NPT Internal Thread (Suffix Hc)
1¼″ Dia
Dia*
Bore*
¼″

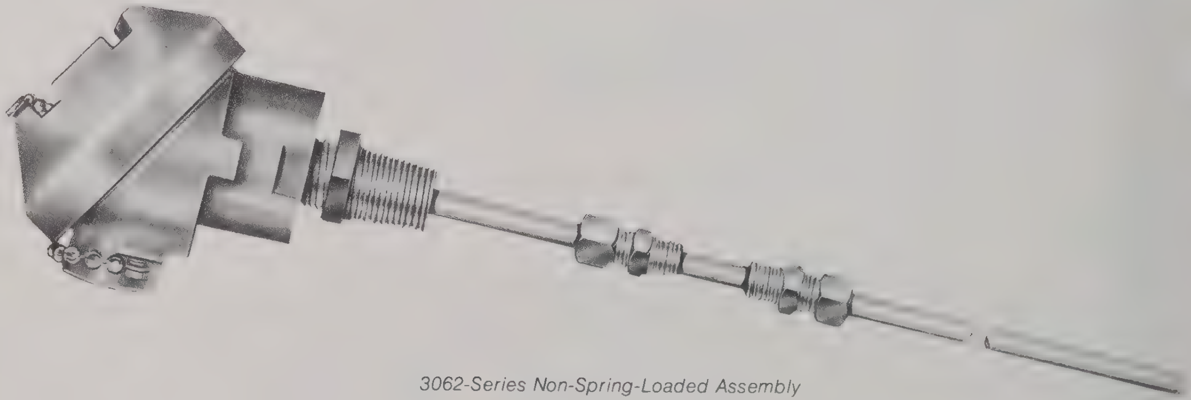
*3207: Bore, 0.260″ ±0.002″; Dia., ¾″;
3217: Bore, 0.385″ ±0.002″; Dia., ⅞″

Figure J. 3207 and 3217 Flanged Wells

3060-Series for Bearing and Contact Temperatures



3060-Series Spring-Loaded Assembly with Oil- and Vapor-Tight Seal



3062-Series Non-Spring-Loaded Assembly (Available with or without Head)

- **For thermocouple measurements requiring tip-contact with measured surface**
- **Spring-loaded assemblies to provide high speed of response and resistance to vibration, with vapor-tight seal or packing gland**
- **Non-spring-loaded assemblies for simple pressure contact**
- **Single or dual elements**
- **Ordering complete assemblies and replacement elements simplified by catalog numbering**

Leeds & Northrup offers a variety of bearing-type thermocouple assemblies, used for tip-sensitive measurements of generator-, motor- or machinery-bearing temperatures, or any surface-temperature application requiring that the tip be held in firm contact for accurate measurement and fast response.

Assemblies are available as spring-loaded elements with compacted ceramic (magnesium oxide) insulation in a metal sheath, or as non-spring-loaded wire-type elements in a metal tube. Single or dual elements of nickel, chromium-constantan (Type E), iron-constantan (Type J), nickel-chromium-nickel, aluminum (Type K), copper constantan (Type T) or Nicrosil-Nisil (Type N) can be provided. Junctions can be grounded to the tip of the sheath or tube, or ungrounded; dual elements in spring-loaded assemblies can also be ungrounded from each other and the sheath.

SPRING-LOADED ASSEMBLIES

Spring-loaded assemblies provide superior speed of response and less sensitivity to vibration.

The 3060-Series (Figure 1) thermocouple assembly comprises an element with compacted ceramic insulation in a 3/16″ OD stainless-steel or Inconel sheath. A retaining washer is silver-soldered on the sheath near the head end; a spring on the sheath is compressible between the retaining washer and the head bushing. The sheath, free to move axially, extends into the bushing, with adequate clearance to permit up to ½″ spring compression. Leads from the element are encapsulated in an epoxy-filled cavity at the upper end of the bushing, providing an oil and vapor seal good to 80 psi. The specified insertion length of the element should be up to ⅜″ more than the distance from the bushing to the measured surface, so that the element is under spring compression when installed.

NON-SPRING-LOADED ASSEMBLIES

The 3062-Series thermocouple assembly comprises an element with asbestos and glass fiber insulation, inserted into a 3/16″ OD spun-and-welded copper or stainless steel tube. The assembly can be supplied with or without a thermocouple head (which includes a mounting bushing and compression fitting), as shown in Figures 2A and 2B. One or two ⅛″ NPT compression fittings can also be supplied in addition to or in place of the head, depending upon the mounting requirements.

One, two or three loose brass ferrules (one for each compression fitting) are provided on the element tube. With the head mounting bushing and/or additional compression fitting(s) threaded into place, the element tube is held in pressure-contact with the measured surface. The compression fitting in the mounting bushing and/or the compressing fitting(s) on the tube are then tightened to lock the ferrule(s), holding the element tip in rigid contact with the surface. (When a replacement element is ordered, one, two or three new ferrules are provided.)

CALIBRATION AND TAGGING OPTIONS

As an option, a thermocouple can be checked at one or more points between −100 and 2300 F, depending upon wire type, gauge and insulation. Correction data is supplied on a linen tag wired to the element or assembly; correction data can also be supplied in a typed report.

Linen, machine-stamped aluminum or electro-etched stainless steel tags can also be provided for identification, with legends as specified.

HOW TO ORDER

A thermocouple-assembly catalog number consists of a base number (e.g. 3060) followed by appropriate suffixes to define the selection.

EXAMPLES

(A.) 3060-2-EE-2-12-0-2-1-207.
Spring-loaded, vapor-tight mounting **(3060),** wires with compacted ceramic in Inconel sheath **(2),** dual-element nickel, chromium-constantan **(EE),** ungrounded junctions **(2),** 12″ uncompressed insertion length **(12),** dual-element cast-iron head **(0-2),** oil- and vapor-tight mounting fitting **(1),** aluminum tag **(207).**
Replacement Element: 3060-2-EE-2-12-0-0-1-000.

(B.) 3062-3-KK-2-60-0-1-2-208-301.
Non-spring-loaded **(3062),** dual-element insulated wires in 304 SS tube **(3),** nickel, chromium-nickel, aluminum **(KK),** ungrounded junction **(2),** 60″ element length **(60),** dual-element aluminum head **(0-1),** two brass compression fittings **(2),** stainless steel identification tag **(208)** and correction data both on a linen tag and in a typed report **(301).**
Replacement Element: 3062-3-KK-2-60-0-0-5-301.

(C.) 3062-3-KK-2-60-0-0-2-208-301.
Same as (B) above, except that head is omitted **(0-0)** and two brass compression fittings are provided on the tube **(2).**
Replacement Element: 3062-3-KK-2-60-0-0-5-301.

REPLACEMENT HEADS

Replacement head assemblies can be ordered by specifying the appropriate L&N Part Number from the table below.

Assembly Catalog Number	Head Assembly*			
	Aluminum		Cast Iron	
	Single-Element	Dual-Element	Single-Element	Dual-Element
3060	042112	042192	352237	352241
3062	042175**	042322**	352246**	042323**

*Conduit opening is tapped ½″ NPT for aluminum head, ¾″ NPT for cast iron. To convert an aluminum head for ¾″ NPT conduit, order an 076955 Adapter. To convert a cast-iron head for ½″ NPT, order an 07636[illegible]
To order a replacement Terminal Block for any Head Asse[illegible] Single-Element Terminal or a 316236 Dual-Element Term[illegible]

**Assembly also includes an 006822 Bushing, 076904 Nut [illegible]

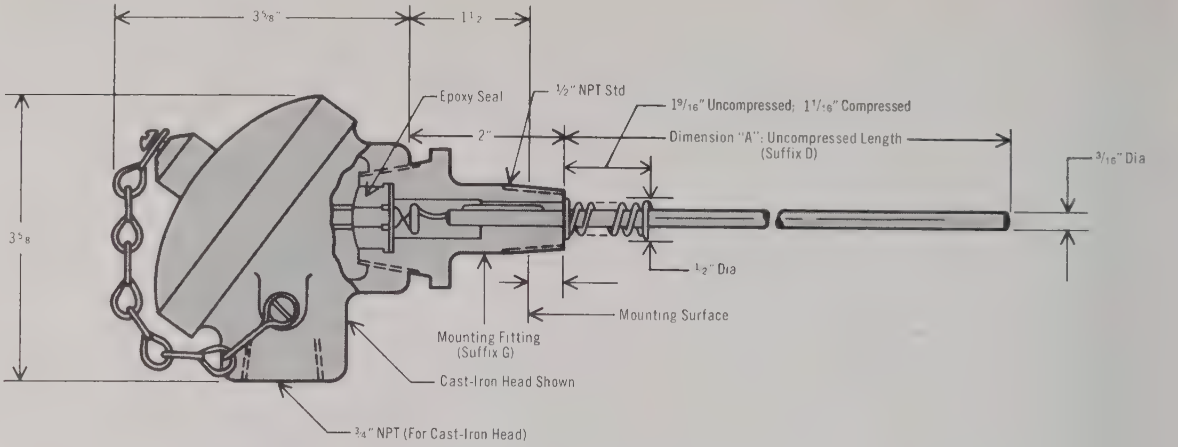

3 5/8"
1 1/2
Epoxy Seal
½" NPT Std
1 9/16" Uncompressed; 1 1/16" Compressed
2"
Dimension "A": Uncompressed Length (Suffix D)
3/16" Dia
3 5/8
½" Dia
Mounting Surface
Mounting Fitting (Suffix G)
Cast-Iron Head Shown
¾" NPT (For Cast-Iron Head)

Figure 1. 3060-Series Head-Mounted Spring-Loaded Assembly with Oil- and Vapor-Tight Seal

A B C D E F G J

3060–□–□–□–□□.□□–□–□–1–□□□

	Description			Suffix
Suffix A: Element Construction	20 AWG Wires with Compacted Ceramic (Magnesium Oxide) Insulation in Metal Sheath	316 SS Sheath, 0.188" OD		1
		Inconel Sheath, 0.188" OD*		2
Suffix B: Thermocouple Type	Single Element	Nickel, Chromium-Constantan		E
		Iron-Constantan		J
		Nickel, Chromium-Nickel, Aluminum		K
		Copper-Constantan		T
		Nicrosil-Nisil (1800 F, Max.)		N
	Dual Element	Nickel, Chromium-Constantan		EE
		Iron-Constantan		JJ
		Nickel, Chromium-Nickel, Aluminum		KK
		Copper-Constantan		TT
		Nicrosil-Nisil (1800 F, Max.)		NN
Suffix C: Type of Junction	Grounded to Tip of Sheath (Single Element or Common-Junction Dual Element)			1
	Ungrounded: Does Not Touch Tip of Sheath (Single Element or Common-Junction Dual Element)			2
	Dual-Element Junctions Ungrounded and Insulated from Each Other and Sheath			3
Suffix D: Insertion Length	Specify Uncompressed Insertion Length (Dimension "A", Figure 1) in **Inches** (2" Min., 60" Max.). Spring Compression, ½". For fractional lengths, use decimal equivalent.			□□.□□
Suffix E-F: Head Assembly	None			0-0
	Single Element	Aluminum, Twist Cap	½" NPT Conduit, 1" NPT Thermocouple	1-0
		Cast Iron, Screw Cap	¾" NPT Conduit, 1" NPT Thermocouple	2-0
	Dual Element	Aluminum, Twist Cap	½" NPT Conduit, 1" NPT Thermocouple	0-1
		Cast Iron, Screw Cap	¾" NPT Conduit, 1" NPT Thermocouple	0-2
Suffix G: Mounting Fitting	Oil- and Vapor-Tight Fitting Molded on Element; ½" NPT on Nipple End, 1" NPT on Head End			1
Suffix J: Options	None			000
	Tagging	1 Linen Tag (Specify Legend)		206
		1 Aluminum Tag, Machine-Stamped, 15 Characters Max. (Specify Legend)		207
		1 Stainless-Steel Tag, Electro-Etched, 22 Characters Max. on Each of Three Lines (Specify Legend)		208
	Calibration	Calibration Check(s): Correction Data Supplied for Any Specified Point(s) Between -100 and 2100 F. (Minimum Element Length, 24".)		
		Correction Data Supplied on Linen Tag		300
		Correction Data Supplied in Typed Report, plus Linen Tag		301
	Universal-Head Conduit Adapter	Converts Aluminum Head ½" NPT Conduit Opening for ¾" NPT Conduit		130
		Converts Cast-Iron Head ¾" NPT Conduit Opening for ½" NPT Conduit		131
	Grounding Connection	Ground Screw Provided Inside Aluminum or Cast-Iron Universal Head for Drain Wire in Conduit Cable		150
	Integral Leadwire	Integral Leadwire Extension(s): Asbestos, Glass-Fiber Insulation. Specify Length in Inches. Head Assembly (Suffix E-F) is Omitted, or Supplied Unmounted		110

Not available with Copper-Constantan (T or TT) thermocouple

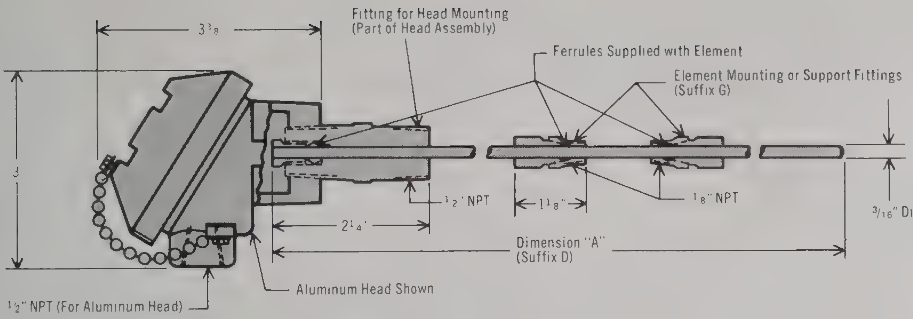

3⅜
Fitting for Head Mounting
(Part of Head Assembly)
Ferrules Supplied with Element
Element Mounting or Support Fittings
(Suffix G)
3
½" NPT
1⅛"
⅛" NPT
3/16" Dia
2¼"
Dimension "A"
(Suffix D)
Aluminum Head Shown
½" NPT (For Aluminum Head)

Figure 2A. 3062-Series Non-Spring-Loaded Assembly with Head

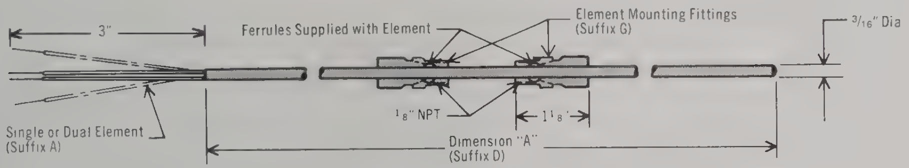

3"
Ferrules Supplied with Element
Element Mounting Fittings
(Suffix G)
3/16" Dia
⅛" NPT
1⅛"
Single or Dual Element
(Suffix A)
Dimension "A"
(Suffix D)

Figure 2B. 3062-Series Non-Spring-Loaded Assembly without Head

A B C D E F G J

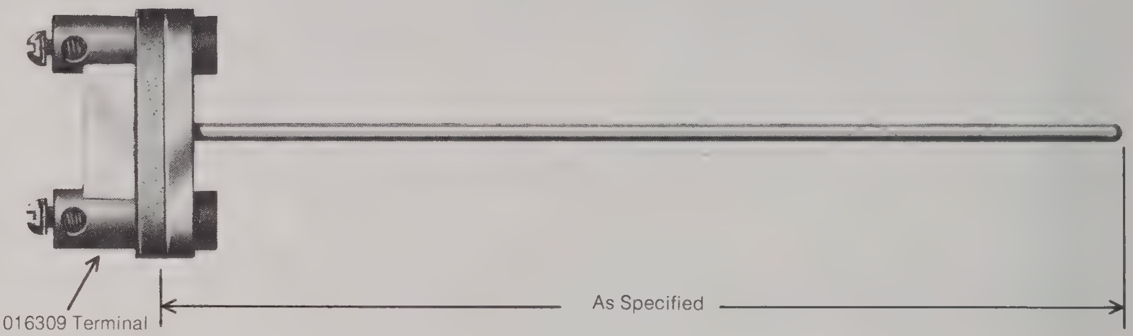
3062–☐–☐–☐–☐☐.☐☐–☐–☐–☐–☐☐☐

	Description			Suffix
Suffix A: Element Construction	Single Element	20 AWG Wires, Asbestos and Glass Fiber Insulated, in Metal Tube	Copper Tube, 0.188" OD	1
			304 SS Tube, 0.188" OD	2
	Dual Element	24 AWG Wires, Asbestos and Glass Fiber Insulated, in Metal Tube	304 SS Tube, 0.188" OD	3
Suffix B: Thermocouple Type	Single Element	Nickel, Chromium-Constantan Iron-Constantan Nickel, Chromium-Nickel, Aluminum Copper-Constantan Nicrosil-Nisil		E J K T N
	Dual Element	Nickel, Chromium-Constantan Iron-Constantan Nickel, Chromium-Nickel, Aluminum Copper-Constantan		EE JJ KK TT
Suffix C: Type of Junction	Grounded to Tip of Tube (Single Element or Common-Junction Dual Element) Ungrounded; Does Not Touch Tip of Tube (Single Element or Common-Junction Dual Element)			1 2
Suffix D: Element Length	Specify Element Length (Dimension "A" in Figure 3A or 3B) in **Inches** (4" Min., 192" Max.).* For fractional lengths, use decimal equivalent			.
Suffix E-F: Head Assembly	None			0-0
	Single Element	Aluminum, Twist Cap	½" NPT Conduit, ½" NPT for Mounting Bushing	1-0
		Cast Iron, Screw Cap	¾" NPT Conduit, ½" NPT for Mounting Bushing	2-0
	Dual Element	Aluminum, Twist Cap	½" NPT Conduit, ½" NPT for Mounting Bushing	0-1
		Cast Iron, Screw Cap	¾" NPT Conduit, ½" NPT for Mounting Bushing	0-2
Suffix G: Mounting Fitting	For Assembly	None One Brass Compression Fitting, ⅛" OD Two Brass Compression Fittings, ⅛" OD		0 1 2
	For Replacement Element Only**	One Ferrule for Mounting Bushing (for Head) Two Ferrules: One for Mounting Bushing (for Head), One for Brass Compression Fitting Three Ferrules: One for Mounting Bushing (for Head), Two for Brass Compression Fittings		3 4 5
Suffix J: Options	Available options are the same as for the 3060-Series; see table on page 26. Untightened Compression Nut in Head Assembly			140

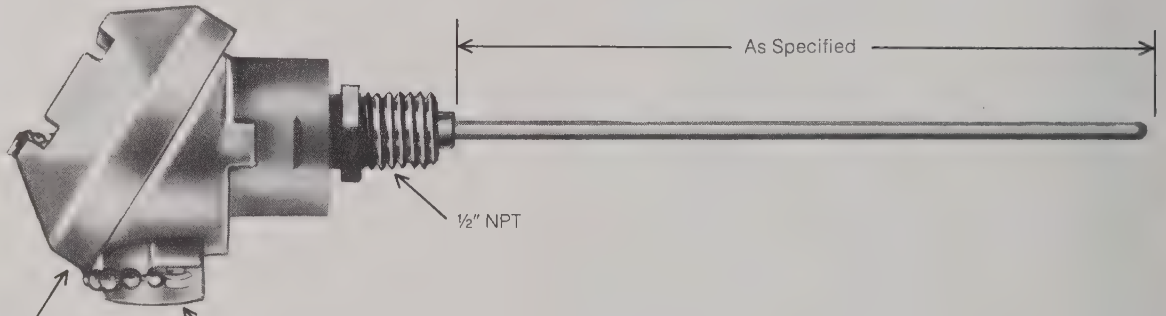
*When a Head is specified, Element Length is insertion length below Mounting Bushing plus 2¼"

**Corresponding suffixes for an Assembly and its Replacement Element are "0" and "3", "1" and "4", and "2" and "5"

8795-Series Miniature Wire-Type Thermocouples



8795-F1



8795-F2-☐-☐

These miniature wire-type thermocouples are particularly well-suited for use in plastic molding, lead soldering and casting pots, food processing, natural and silicone-rubber processing or vulcanizing, in chemical processing and in a variety of applications where its compact, sturdy construction and guaranteed accuracy are important requisites. They are guaranteed to our standard limits of error within their operating ranges. The upper temperature limit for Type J (700 F), Type K (900 F), Type E (400 F) and Type T (400 F).

The element consists of 24 AWG duplex insulated thermocouple wire in 18% chromium-8% nickel (Type 304 stainless-steel) protecting tube, ⅛″ OD. The thermocouple junction is welded to the closed end of the tube (grounded junction), thus providing the fastest possible response to temperature changes.

The 8795 can be provided: (a) without a terminal connector, with or without a mounting fitting; (b) with an open-type terminal connector, with or without a mounting fitting; or (c) with an aluminum Universal Head, with a double-threaded (½″ NPT) mounting bushing

HOW TO ORDER Specify the appropriate catalog number and suffixes, depending upon the terminal connectors and/or fittings desired (see Table). Add the length in inches as the first suffix, and the TC type as the second suffix. Example: 8795-F2-8-J specifies a Type J thermocouple in a ⅛″ OD stainless-steel tube (8 inches long) with an aluminum head and ½″ NPT double enocl mounting bushing.

Terminal Connector	Mounting Fitting	Catalog Number
None: Element only, with 5¼″ Bare Leads	None	**8795- -**
	076184 Brass Compression Fitting, with ⅛″ NPT. Mounts Anywhere Along Element	**8795-F3-☐-☐**
016309 Open-Type Terminal Connector (Screw-Clamp Terminals) and 034498 Protector	None	**8795-F1- -**
	076184 Brass Compression Fitting	**8795-F4-☐-☐**
042113 Aluminum Universal Head with ½″ NPT Double-Threaded Bushing	None (See Head)	**8795-F2-☐-☐**

8784-Series with Compacted-Ceramic Insulation

8784 Assembly with Miniature Head

- **Small size, fast response**
- **Long life, with minimum long-term calibration drift**
- **Excellent high-temperature insulation**
- **Single or dual elements**
- **Choice of thermocouples—E, J, K, T, N or S—with exposed, grounded or ungrounded junctions**
- **Wide variety of sheath materials and sizes**
- **Choice of miniature or Universal terminal heads, Quick-Disconnect terminals or integral leadwire extensions**
- **Ordering complete assemblies and replacement elements simplified by catalog numbering**

Compacted-ceramic thermocouple assemblies consist of single- or dual-element thermocouple wires, "hard-packed" magnesium-oxide insulation and an Inconel or stainless-steel sheath in one rigid, compact unit. They offer the advantages of small size, fast response and longer life than wire-type thermocouples. For a given wire size, the time/temperature effect on thermal/emf stability is less for compacted-ceramic insulated thermocouples than for standard wire-type elements.

These assemblies can be used at a maximum external pressure of 50,000 psi at temperatures up to 1200 F; can be bent on an inside radius equal to the sheath diameter, without rupture or loss of insulation; can be supplied in integral lengths as long as 40 feet. (Horizontally-mounted assemblies longer than 36" should be supported.)

The time constant (the time required for an element to respond to 63.2% of a step-change in temperature) is a function of wire size, and the values listed below are for a grounded junction.

Sheath Diameter	Wire Size	Time Constant
1/16"	30 AWG	0.25 sec.
1/8"	24 AWG	0.50 sec.
3/16"	20 AWG	1.00 sec.
1/4"	18 AWG	1.70 sec.
5/16"	16 AWG	2.00 sec.

THERMOCOUPLE TYPES

Type J (iron-constantan) thermocouples are specified for general use up to 1400 F. Featuring high and fairly uniform sensitivity in millivolts/degree change, and excellent service life, Type J is the most widely used of all industrial thermocouples.

Type K (nickel, chromium-nickel, aluminum) is most commonly used over the high-temperature range of 1400 to 2300 F (limited to 2100 F by the sheath materials available).

Type E (nickel, chromium-constantan) provides the highest millivolt/degree output, for maximum sensitivity — makes this thermocouple especially useful (up to 1600 F) for short ranges or differential-temperature measurements. (As an option, Type E elements can be supplied with "premium-grade accuracy" — see "Limits of Error", below.)

Type N (nicrosil-nisil) provides superior thermal stability, longer life and better accuracy for longer time periods than Type K. Limited to 2100°F by sheath materials. Available in 3/16, 1/4 and 5/16 dia. only.

Type T (copper-constantan) is applicable below 600 F, and is highly stable at sub-zero temperatures, with a high conformity to published calibration data.

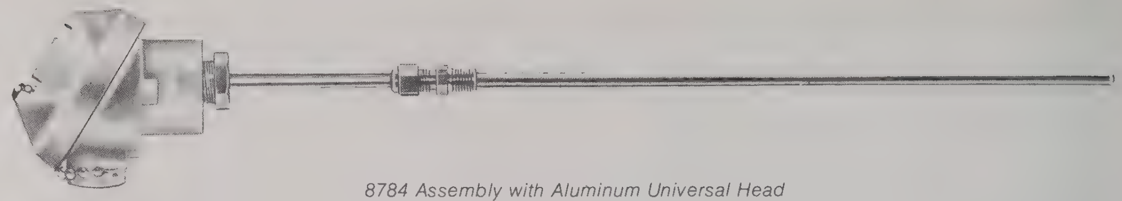
Type S (platinum, 10% rhodium-platinum), IPTS 68 calibration, is used for high-accuracy, high-temperature applications, here limited by the 2100 F restriction on the 3/16" OD Inconel 600 sheath.

LIMITS OF ERROR

8784-Series Thermocouples are supplied to meet the following limits of error, referenced to IPTS 68.

ANSI	Thermocouple Type	Temperature Range*	Limits of Error	
			Standard	Premium Grade**
J	Iron-Constantan	−100 to +800 F 800 to 1400 F	±4 F ±½%	— –
K	Nickel, Chromium-Nickel, Aluminum	32 to 530 F 530 to 2100 F	±4 F ±¾%	— —
E	Nickel, Chromium-Constantan	32 to 600 F 600 to 1600 F	±3 F ±½%	±2 F ±⅜%
T	Copper-Constantan	−150 to −75 F −75 to +200 F 200 to 700 F	±2% ±1½ F ±¾%	— —
N	Nicrosil-Nisil	32 to 530 F 530 to 2300 F	±4 F ±¾%	
S	Platinum, 10% Rhodium-Platinum	0 to 1000 F 1000 to 2100 F	±2.5 F ±0.25%	— —

*Upper limit for Types K, N and S is restricted by sheath material available
**Type E can be specified for "premium-grade accuracy" see "Suffix H [illegible]
[illegible]



8784 Assembly with Aluminum Universal Head

Sheath Materials: A variety of sheath materials is available in sizes ranging from 1/16″ OD to 5/16″ OD. For material characteristics and applications, see table, "Sheath Materials" on page 35. For sheath materials and diameters available for specific thermocouple types, see the "Element Availability Table," also on page 35.

Junctions: Single-element thermocouple junctions can be supplied *grounded*, with the junction enclosed in the welded end of the sheath; *ungrounded*, with the junction insulated from the sheath; or *exposed*, with the lacquered junction projecting from the sheath and the open end sealed with cement. Dual elements with a common junction can be supplied grounded, ungrounded or exposed; dual elements can also be supplied with separate junctions, ungrounded and insulated from each other and the sheath. Note: Type S junctions can only be supplied ungrounded.

Terminations: A variety of terminal connections makes the 8784-Series Thermocouple a highly versatile offering.

When ordered without a head termination, the element is provided with 3-inch leadwire extensions beyond the end of the sheath. As an option (See Suffix H), leadwire extensions of any specified length, in a choice of insulation materials, can be supplied for all elements except Type S.

For permanent or semi-permanent installations, the thermocouple can be provided with a miniature terminal head, or a choice of Universal heads: twist-cap, weather-tight aluminum, or screw-cap, water-tight cast iron. The Universal heads can also be equipped with a ½″ NPT Mounting Bushing.

For testing, and similar applications where it is desirable to change thermocouple connections quickly and easily, the 8784-Series can be equipped with Quick-Disconnect terminals which provide positive identification (ISA color-coded), long-life reliability and installation simplicity. Terminals can be single- or dual-element, male or female, with or without mating connector, etc.

Mounting Bushing on Sheath: As an option, a 316 SS Compression Fitting, with ⅛″ or ¼″ NPT threads, can be provided for mounting on the sheath. The Fitting may be either permanent-type with steel ferrules (cannot be relocated when once tightened) or, using Teflon ferrules, may be repositioned as required. The Teflon ferrules cannot be repositioned if exposed to temperatures above 400 F

Calibration Data: Correction data can be supplied for any specified point(s) between −100 and 2100 F depending upon wire type, gauge and insulation. Minimum element is 24″. Data is provided on a linen tag wired to the element or assembly...can also be provided in a typed report.

The table below provides a guide for specifying the number and location of check points for correction data; other or additional points may be specified.

Temperature Range Span	Check Points	Check Points Taken At:
400 F or Less	1	High End of Span
800 F or Less	2	Mid-range and High End
1200 F or Less	3	1/3, 2/3 and High End
1600 F or Less	4	1/4, 1/2, 3/4 and High End
2000 F or Less	5	1/5, 2/5, 3/5, 4/5 and High End

Tagging: Linen, machine-stamped aluminum or electro-etched stainless-steel tags, with legends as specified, can be wired to the element or assembly for identification.

HOW TO ORDER

The catalog numbering system simplifies ordering an 8784 thermocouple in any of a variety of configurations.

In sequence, the catalog number comprises:

the base number, 8784, to define a compacted-ceramic thermocouple;

Suffix A, B, C, D and E to describe the element: thermocouple Type, sheath material and diameter, element length and junction;

Suffix F to specify the head termination, if any;

Suffix G to specify a Mounting Fitting on the sheath, if any;

Suffix H to specify any options: tagging, calibration, leadwire extensions, etc.

Note: Be certain to check the "Element Availability Table" on page 35 to verify what sheath materials and diameters are available for any single or dual element.

EXAMPLES

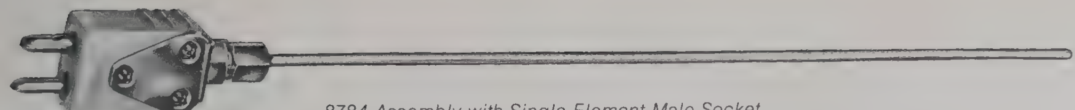
8784-K-1-5-18-1-01-1-000

Specifies a compacted-ceramic thermocouple **(8784)** with single-element nickel, chromium-nickel, aluminum wires **(K)** in an Inconel 600 sheath **(1)** 5/16″ OD **(5)**, 18″ long **(18)**, with grounded junction **(1)**; miniature head **(01)**; sheath mounting fitting, for permanent positioning **(1)**; no options **(000)**.

Replacement Element: 8784-K-1-5-18-1-09-1-000.

8784-J-3-4-24-2-00-2-102-206

Specifies a compacted-ceramic thermocouple **(8784)** with single-element iron-constantan wires **(J)** in a 316 stainless steel sheath **(3)** ¼″ OD **(4)**, 24″ long **(24)**, with ungrounded junction **(2)**; no head termination **(00)**, sheath mounting fitting, for adjustable positioning **(2)**. Teflon-insulated integral leadwire extensions **(102)**, length as specified; linen tag **(206)**, with legend as specified.



8784 Assembly with Single-Element Male Socket

A B C D E F G H

8784–☐–☐–☐–☐–☐–☐☐–☐–☐☐☐

	Description		Suffix
Suffix A: Thermocouple Type	Single Element	Nickel, Chromium-Constantan	E*
		Iron-Constantan	J
		Nickel, Chromium-Nickel, Aluminum	K
		Copper-Constantan	T
		Platinum, 10% Rhodium-Platinum	S**
		Nicrosil-Nisil	N
	Dual Element	Nickel, Chromium-Constantan	EE*
		Iron-Constantan	JJ
		Nickel, Chromium-Nickel, Aluminum	KK
		Copper-Constantan	TT
		Nicrosil-Nisil	NN
Suffix B: Sheath Material	Inconel 600 (2100 F or 1150 C, Max.)		1
	310 Stainless Steel (2100 F or 1150 C, Max.)		2
	316 Stainless Steel (1650 F or 900 C, Max.)		3
	304 Stainless Steel (1650 F or 900 C, Max.)		4
	347 Stainless Steel (1650 F or 900 C, Max.)		5
Suffix C: Sheath Diameter	1/16" (0.062"; 1.59 mm)		1
	1/8" (0.125"; 3.18 mm)		2
	3/16" (0.188"; 4.76 mm), for Type E, J, K, T or N		3
	3/16" (0.188"; 4.76 mm), for Type S only		6
	1/4" (0.250"; 6.35 mm)		4
	5/16" (0.313"; 7.94 mm)		5
Suffix D: Element Length	Specify Dimension "A", in *Inches*. Minimum length, 1"; maximum length, 480".		☐
Suffix E: Type of Junction	Grounded to Tip of Sheath (Single Element or Common-Junction Dual Element)		1
	Ungrounded; Does Not Touch Tip of Sheath (Single Element or Common-Junction Dual Element)***		2
	Exposed, with Lacquered Tip, Cement Seal (Single Element or Common-Junction Dual Element)		3
	Dual-Element Junctions Ungrounded and Insulated from Each Other and Sheath***		4
Suffix F: Head Termination	None; Element Only, with Standard 3" Leadwire Extensions (Figure A or B) or with Integral Leadwire Extension Option (Figure C, D or E)		00
	Element with Bushing for Head (Replacement Element for Option 01, 02 or 03 Only)		09
	Element with Double-Ended Mounting Bushing (Replacement Element for Option 22 or 23)		29
	Miniature Head: 042001 for Single Element or 042214 for Dual Element (Figure F)		01
	Miniature Plastic Weatherproof Head (Figure G) Accommodates Single or Dual Thermocouples		11
	Universal Head, Single or Dual Element****	Aluminum, Twist Cap (Figure H, but Without Bushing)	02
		Aluminum, with 1/2" NPT Mounting Bushing (Figure H)	22
		Aluminum, with 1/4" NPT Spring-Loaded Mounting Bushing (Similar to Figure H)	30
		Cast-Iron, Screw Cap (Figure I)	03
		Cast-Iron, with 1/2" NPT Mounting Bushing (Figure J)	23
		Cast-Iron, with 1/4" NPT Spring-Loaded Mounting Bushing (Similar to Figure J)	31
	Male Quick Disconnect Attached to Single or Dual Element *****	Male Disconnect Only (Figure K or L)	07
		Includes Female Mating Connector (Figure M or N)	17
		Includes Female Mating Connector with Cable Clamp, for Single Element Only (Figure O)	27
	Female Quick Disconnect Attached to Single or Dual Element*****	Female Disconnect Only (Figure K or L)	08
		Includes Male Mating Connector (Figure M or N)	18
		Includes Male Mating Connector with Cable Clamp, for Single Element Only (Figure O)	28
Suffix G: Sheath Mounting Fitting	None		0
	Compression Fitting, 316 SS; 1/8" NPT on 1/16", 1/8" or 3/16" dia. Sheath; 1/4" NPT on 1/4" or 5/16" dia. Sheath	Permanent Positioning, with Steel Ferrules (076909 for 1/16" Sheath; 076525 for 1/8"; 076782 for 3/16"; 276188 for 1/4"; 076600 for 5/16")	1
		Adjustable Positioning, with Teflon Ferrules (033575 for 1/16" Sheath; 033576 for 1/8"; 033577 for 3/16"; 033578 for 1/4"; 033579 for 5/16")	2

Continued on page 35

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*For premium-grade accuracy, see Option 310 under Suffix H.

**Available only in 3/16" OD Inconel 600 sheath with ungrounded junction; specify as 8784-S-1-6-☐-2 ☐-☐☐-☐-☐☐☐ with appropriate suffixes

***Sheath diameter of single element must be larger than 1/16"; of dual element, larger than 1/8"

****Conduit opening is tapped 1/2" NPT for aluminum head, 3/4" NPT for cast iron. To convert an aluminum head for 3/4" NPT conduit, specify Option 130. To convert a cast iron head for 1/2" NPT, specify Option 131.

*****Dual-element Quick Disconnects are available for elements with 3/16" and 1/4" sheath diameter only.

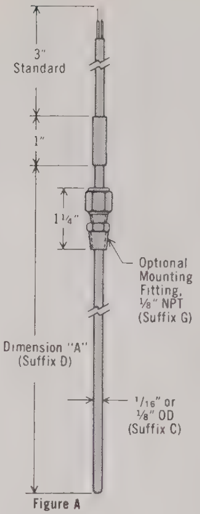

3"
Standard
1"
1¼"
Optional
Mounting
Fitting,
⅛" NPT
(Suffix G)
Dimension "A"
(Suffix D)
1/16" or
⅛" OD
(Suffix C)

Figure A

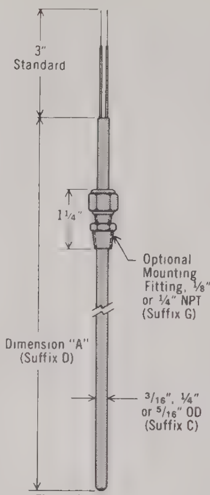

3"
Standard
1¼"
Optional
Mounting
Fitting, ⅛"
or ¼" NPT
(Suffix G)
Dimension "A"
(Suffix D)
3/16", ¼"
or 5/16" OD
(Suffix C)

Figure B

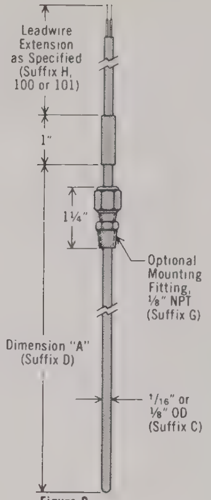

Leadwire
Extension
as Specified
(Suffix H,
100 or 101)
1"
1¼"
Optional
Mounting
Fitting,
⅛" NPT
(Suffix G)
Dimension "A"
(Suffix D)
1/16" or
⅛" OD
(Suffix C)

Figure C

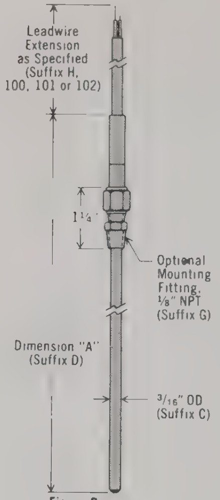

Leadwire
Extension
as Specified
(Suffix H,
100, 101 or 102)
1¼"
Optional
Mounting
Fitting,
⅛" NPT
(Suffix G)
Dimension "A"
(Suffix D)
3/16" OD
(Suffix C)

Figure D

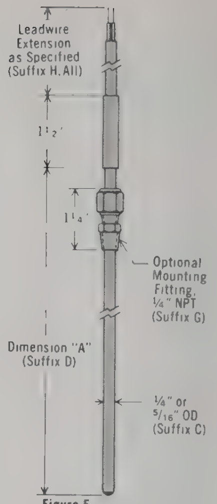

Leadwire
Extension
as Specified
(Suffix H, All)
1½"
1¼"
Optional
Mounting
Fitting,
¼" NPT
(Suffix G)
Dimension "A"
(Suffix D)
¼" or
5/16" OD
(Suffix C)

Figure E

Elements Only

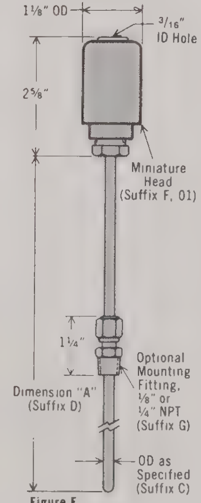

1⅛" OD
3/16"
ID Hole
2⅝"
Miniature
Head
(Suffix F, 01)
1¼"
Optional
Mounting
Fitting,
⅛" or
¼" NPT
(Suffix G)
Dimension "A"
(Suffix D)
OD as
Specified
(Suffix C)

Figure F

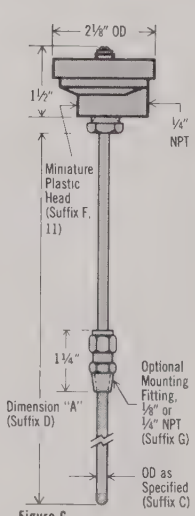

2⅛" OD
1½"
¼"
NPT
Miniature
Plastic
Head
(Suffix F,
11)
1¼"
Optional
Mounting
Fitting,
⅛" or
¼" NPT
(Suffix G)
Dimension "A"
(Suffix D)
OD as
Specified
(Suffix C)

Figure G

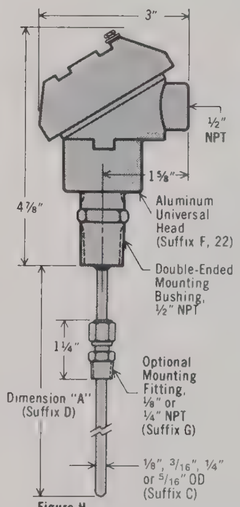

3"
½"
NPT
1⅝"
4⅞"
Aluminum
Universal
Head
(Suffix F, 22)
Double-Ended
Mounting
Bushing,
½" NPT
1¼"
Optional
Mounting
Fitting,
⅛" or
¼" NPT
(Suffix G)
Dimension "A"
(Suffix D)
⅛", 3/16", ¼"
or 5/16" OD
(Suffix C)

Figure H

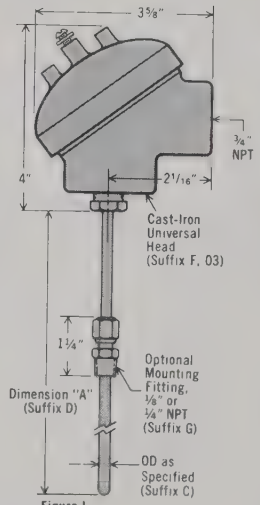

3⅝"
¾"
NPT
4"
2 1/16"
Cast-Iron
Universal
Head
(Suffix F, 03)
1¼"
Optional
Mounting
Fitting,
⅛" or
¼" NPT
(Suffix G)
Dimension "A"
(Suffix D)
OD as
Specified
(Suffix C)

Figure I

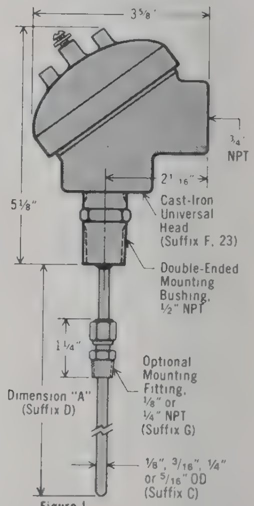

3⅝"
¾"
NPT
5⅛"
2 1/16"
Cast-Iron
Universal
Head
(Suffix F, 23)
Double-Ended
Mounting
Bushing,
½" NPT
1¼"
Optional
Mounting
Fitting,
⅛" or
¼" NPT
(Suffix G)
Dimension "A"
(Suffix D)
⅛", 3/16", ¼"
or 5/16" OD
(Suffix C)

Figure J

Elements With Head

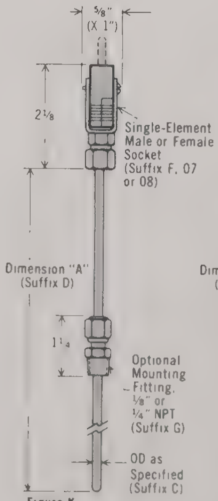

⅝"
(X 1")
2⅛
Single-Element
Male or Female
Socket
(Suffix F, 07
or 08)
Dimension "A"
(Suffix D)
1¼
Optional
Mounting
Fitting,
⅛" or
¼" NPT
(Suffix G)
OD as
Specified
(Suffix C)

Figure K

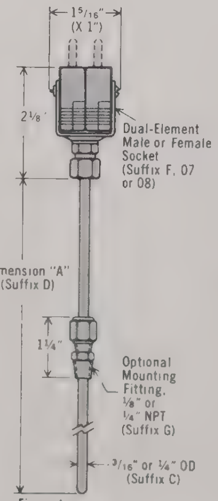

1 5/16"
(X 1")
2⅛"
Dual-Element
Male or Female
Socket
(Suffix F, 07
or 08)
Dimension "A"
(Suffix D)
1¼"
Optional
Mounting
Fitting,
⅛" or
¼" NPT
(Suffix G)
3/16" or ¼" OD
(Suffix C)

Figure L

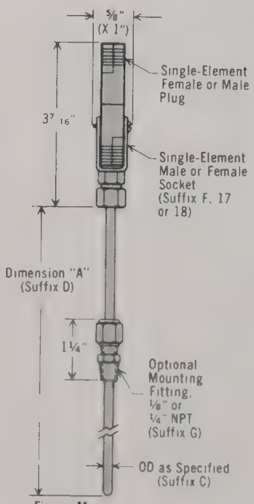

⅝"
(X 1")
Single-Element
Female or Male
Plug
3 7/16"
Single-Element
Male or Female
Socket
(Suffix F, 17
or 18)
Dimension "A"
(Suffix D)
1¼"
Optional
Mounting
Fitting,
⅛" or
¼" NPT
(Suffix G)
OD as Specified
(Suffix C)

Figure M

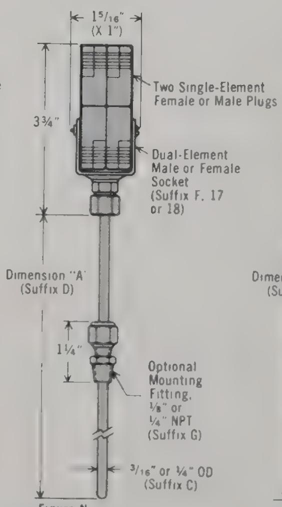

1 5/16"
(X 1")
Two Single-Element
Female or Male Plugs
3¾"
Dual-Element
Male or Female
Socket
(Suffix F, 17
or 18)
Dimension "A"
(Suffix D)
1¼"
Optional
Mounting
Fitting,
⅛" or
¼" NPT
(Suffix G)
3/16" or ¼" OD
(Suffix C)

Figure N

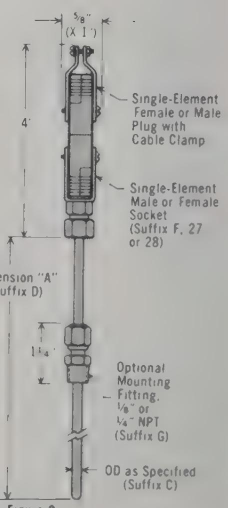

⅝"
(X 1")
Single-Element
Female or Male
Plug with
Cable Clamp
4"
Single-Element
Male or Female
Socket
(Suffix F, 27
or 28)
Dimension "A"
(Suffix D)
1¼"
Optional
Mounting
Fitting,
⅛" or
¼" NPT
(Suffix G)
OD as Specified
(Suffix C)

Figure O

Elements With Quick Disconnects

		Description	Suffix
Suffix H: Options	None		000
	Tagging	1 Linen Tag (Specify Legend)	206
		1 Aluminum Tag, Machine-Stamped, 15 Characters Max. (Specify Legend)	207
		1 Stainless-Steel Tag, Electro-Etched, 22 Characters Max. on Each of Three Lines (Specify Legend)	208
	Calibration	Calibration Check(s): Correction Data Supplied for Any Specified Point(s) Between −100 and 2100 F. (Minimum Element Length, 24".) For Suggested Points, see Table Under "Calibration Data".	
		Correction Data Supplied on Linen Tag	300
		Correction Data Supplied in Typed Report, plus Linen Tag	301
		Premium-Grade Accuracy Element: Available for Type E or EE, in ¼" or 5/16" dia. 304 SS Sheath Only	310
	Integral Leadwire Extensions*	Insulation: Synthetic Fiber, with Glass Braid Overall. 500 F, Max. Not Available for Type E, N or T.	100
		Insulation: Glass Wrap, with Glass Braid Overall. 1000 F, Max.	101
		Insulation: Teflon (FEP), with Teflon (FEP) Overall. 500 F, Max. For Sheath dia. 3/16", ¼" or 5/16" Only.	102
		Insulation: Polyvinyl, with Polyvinyl Overall. 220 F, Max. For Sheath dia. ¼" or 5/16" Only. Not Available for Type K.	103
	Universal-Head Conduit Adapter	Converts Aluminum Head ½" NPT Conduit Opening for ¾" NPT Conduit	130
		Converts Cast-Iron Head ¾" NPT Conduit Opening for ½" NPT Conduit	131
	Grounding Connection.	Ground Screw Provided Inside Aluminum or Cast-Iron Universal Head for Drain Wire in Conduit Cable	150

*Available for single-element base-metal thermocouples only. Specify length of extension in inches. Suffix F must be "00"

ELEMENT AVAILABILITY TABLE

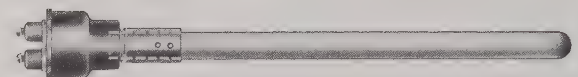
SINGLE ELEMENT†					SHEATH			DUAL ELEMENT				
N	E	J	K	T	OD	MATERIAL	OD	EE	JJ	KK	TT	NN
NA	NA	*	*	NA	1/16"	Inconel 600	1/16"	NA	NA	NA	NA	NA
NA	NA	*	*	NA	⅛"		⅛"	NA	NA	NA	NA	NA
*	*	*	*	NA	3/16"		3/16"	*	*	*	NA	*
*	*	*	*	NA	¼"		¼"	*	*	*	NA	*
*	*	*	*	NA	5/16"		5/16"	*	*	*	NA	*
NA	NA	NA	*	NA	3/16"	310 SS	3/16"	NA	NA	*	NA	NA
NA	NA	*	*	NA	¼"		¼"	NA	*	*	NA	NA
NA	NA	*	*	NA	5/16"		5/16"	NA	*	*	NA	NA
NA	NA	*	*	*	1/16"	316 SS	1/16"	NA	NA	NA	NA	NA
NA	NA	*	*	*	⅛"		⅛"	NA	NA	NA	NA	NA
*	*	*	*	*	3/16"		3/16"	*	*	*	*	*
*	*	*	*	*	¼		¼	*	*	*	*	*
*	*	*	*	*	5/16"		5/16"	*	*	*	*	*
NA	NA	*	*	NA	1/16"	304 SS	1/16"	NA	NA	NA	NA	NA
NA	NA	NA	*	*	⅛"		⅛"	NA	NA	NA	NA	NA
NA	*	*	*	*	3/16"		3/16"	*	*	*	*	NA
NA	*	*	*	*	¼"		¼"	*	*	*	*	NA
NA	*	*	*	*	5/16"		5/16"	*	*	*	*	NA
NA	NA	NA	*	NA	3/16"	347 SS	3/16"	NA	NA	NA	NA	NA
NA	NA	NA	*	NA	¼"		¼"	NA	NA	NA	NA	NA
NA	NA	NA	*	NA	5/16"		5/16"	NA	NA	NA	NA	NA

*Element is available in sheath material and diameter.
NA: Not available from stock.
†A Type S thermocouple is available only as a single element in a 3/16" OD Inconel sheath

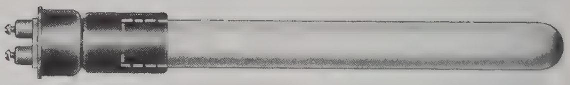
SHEATH MATERIALS

Type	Maximum Temperature (Air)	Description
Inconel 600	2100 F	Good in corrosive atmosphere at high temperature. Not recommended for use in sulfur or reducing atmospheres. Melting point, 2570 F.
310 SS	2100 F	Excellent corrosion resistance. Provides good resistance to both carburizing and reducing environments. Subject to carbide precipitation in the 900-1600 F range. Melting point, 2570 F.
316 SS	1650 F	Superior to 304 SS in corrosion resistance. Resists pitting in phosphorous and acetic acids. Subject to carbide precipitation in the 800-1500 F range. Not recommended for use in reducing atmospheres. Melting point, 2550 F.
304 SS	1650 F	Resistant to oxidation and corrosion. Generally used in process applications such as steam lines, oil refineries and chemical solutions. Resists nitric acids well, halogen acids poorly and the sulfur acids moderately. Subject to carbide precipitation in the 900-1600 F range. Not recommended for use in reducing atmospheres. Melting point, 2550 F
347 SS	1650 F	Columbium-stabilized stainless steel. Excellent resistance to intergranular corrosion in the 800-1600 F range. Not recommended for use in reducing atmospheres. Melting point, 2550 F.

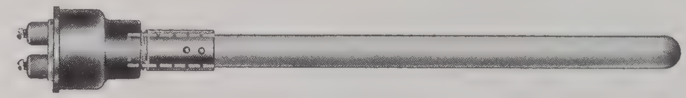
3080-Series Industrial Platinum Thermocouples



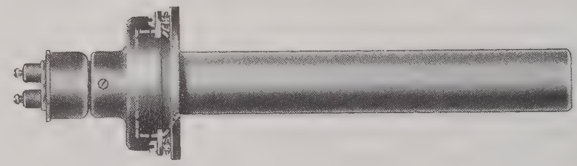
Open Terminal Head and Ceramic Primary Tube Only



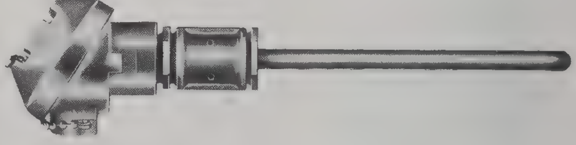
Open-Terminal Head and Ceramic Primary and Secondary Tubes



Open-Terminal Head with Extension Leads and Ceramic Primary Tube Only



Open-Terminal Head and Ceramic Primary, Silicon Carbide Secondary Tubes



Universal Head and Ceramic Primary, Metal Secondary Tubes

- **For thermocouple measurements of temperatures above the range of base-metal couples, to 3100 F**
- **For more-precise measurements at lower temperatures where the additional cost is justified**
- **For reference-standard measurements in calibrating working-standard thermocouples**
- **Wide variety of assemblies in ceramic primary tubes, or ceramic primary tubes with ceramic or metal secondary tubes**
- **Ordering complete assemblies, replacement elements or replacement tubes simplified by catalog numbering**

In industrial applications, Type R, S and B noble-metal thermocouples are predominantly used where temperatures exceed the upper limits of base-metal thermocouples. Because of their calibration stability when properly handled, they may also be used as reference standards to calibrate working standards. These stability characteristics also promote their use within the temperature limits of base-metal thermocouples, in applications where a more precise measurement justifies the additional cost

For these applications, Leeds & Northrup offers a wide variety of assemblies with ceramic primary protection tubes only, or combinations of ceramic primary tubes with ceramic, metal-ceramic or metal secondary tubes Various mounting arrangements — adjustable flanges or threaded bushings — can also be provided

Thermocouple Calibration: Calibration is indicated by the base catalog number. All thermocouples for use with *new* equipment should be ordered to conform with IPTS 68 Calibration (3080-). Type R and S thermocouple elements and assemblies can also be supplied with IPTS 48 Calibration (3081-) for use with existing instrumentation so calibrated. (See "Calibration Data Options", below.)

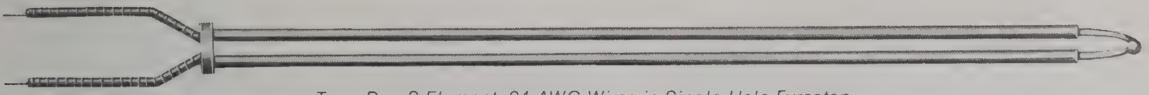
Thermocouple Elements: Wire size is 24 AWG. Type R and S wires are protected by single-hole Fyrestan* insulators; Type B wires, by one-piece, two-hole high-purity alumina insulators. Small fish-spine insulators are used on the wires near the terminal ends, providing flexibility as well as protection. The hot junction of the element is positioned approximately ⅜" from the bottom of the primary tube

Recommended maximum operating temperature in a normal, non-corrosive oxidizing atmosphere is 2700 F for Types R and S, 3100 F for Type B

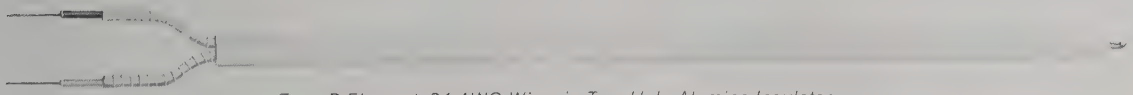
Primary Protection Tubes: L&N Fyrestan (highly refractory porcelain) tubes are used for Type R and S assemblies; when mounted vertically, maximum temperature is 2800 F (when mounted horizontally, recommended maximum temperatures are 2500 and 2300 F for unsupported lengths of 12 and 18 inches respectively).

High-purity alumina tubes are used for Type B assemblies (can also be supplied for Type R or S, where desired); when mounted vertically, maximum temperature is 3400 F (when mounted horizontally, the tube must be supported at temperatures above 3000 F)

If no secondary tube is employed, application of these primary tubes is limited to pressures no greater than 1 psig



Type R or S Element: 24 AWG Wires in Single-Hole Fyrestan Insulators, Fish-Spine Insulators on Extensions



Type B Element: 24 AWG Wires in Two-Hole Alumina Insulator, Fish-Spine Insulators on Extensions

Secondary Protection Tubes: For improved mechanical protection and/or impermeability, assemblies are available which combine a primary tube within a secondary protection tube.

Type B thermocouples must be supplied in an alumina primary tube with either an alumina or silicon carbide (3000 F, max.) secondary tube.

Types R and S thermocouples can be supplied in a Fyrestan (or alumina) primary tube and a Fyrestan, alumina, silicon carbide, metal-ceramic (2500 F, max.), Inconel (2100 F, max.) or 446 stainless-steel (2000 F, max.) secondary tube.

Metal secondary tubes permit applications at pressures up to 50 psig.

Thermocouple Heads: Most assemblies are available in a choice of an Open-Terminal or a Universal Head.

The Open-Terminal Head has a top plate with exposed binding posts on top for extension-wire connections, and screw-type terminals beneath for thermocouple connections. Remove two screws, and the plate and thermocouple element can be withdrawn intact from the assembly.

The cast-iron Universal Head features a screw-type cap — secured by a chain — with a heat- and moisture-proof gasket, to protect the terminal connectors within. (Cap design permits leverage to be applied for easy removal, even when hot.) Thermocouple and extension wire connections are screw-clamped; the element can be readily withdrawn or replaced without disturbing the assembly.

Mounting: To facilitate mounting, assemblies comprising only a primary tube can be specified with an integral ¾″ NPT mounting bushing (Fig. D) or an adjustable cast-iron flange which clamps to an Inconel sleeve (Fig. C). Assemblies with a silicon-carbide secondary tube can be provided with a two-piece spring-type flange which clamps to the tube (Fig. E and F). Assemblies in metal secondary tubes (Fig. K and L) can be provided with either an adjustable cast-iron flange or with a steel bushing (1″, 1¼″ or 1½″ NPT) welded to the tube

Calibration Data Options: L&N can provide either Calibration Checks, or an L&N Report of Calibration, as required by the application.

Calibration Checks: Correction data is supplied for any specified temperature point(s) between 33 and 3000 F. Data is provided on a linen tag, wired to the element or assembly . . . can also be provided in a typed report Applies to all thermocouple types, 24″ minimum length.

L&N Report of Calibration Since specifying an NBS Report results in some delay, we have set up an L&N Report of Calibration as a service to customers.

Thermocouples are made from selected annealed platinum, 10% rhodium wire (24-1-63) and platinum wire (24-1-6), samples of which have been calibrated at the freezing points of gold, 1064.43 C (1947.97 F), silver, 961.93 C (1763.47 F), antimony, 630.74 C (1167.33 F), and zinc 419.58 C (787.24 F) by the NBS. Because of the high accuracy of this type of calibration (±2 microvolts at each fixed point) and also because of the uniformity in thermoelectric properties of the wire, the values are at least as accurate as if the thermocouple had been calibrated directly by comparison with a standard thermocouple. Using the report from NBS as a basis, L&N will supply a report giving the emf in absolute millivolts versus temperature in degrees C, in one-degree steps from 0 to 1450 C with the reference junction at 0 C. Minimum length of thermocouple to be supplied with a report is 24 inches. (This report can also be supplied in one-degree Fahrenheit steps from 32 to 2650 F.)

The L&N Report will state a somewhat lower accuracy than the comparable Bureau Report . . . 0.75 C in the range of 0 to 1100 C as compared to 0.5 C, but both Reports increase to a maximum of 2 C at 1450 C.

HOW TO ORDER

The catalog numbering system simplifies ordering (a) a complete assembly — element, head and protection tube(s); (b) a replacement element only; (c) a replacement primary tube; or (d) a replacement secondary tube. (Any of these can be ordered tagged for temporary or permanent identification.)

In sequence, the catalog number comprises

A base number (3080 or 3081) to define the IPTS calibration;

Suffix A (S, R or B) to define the type of thermocouple element;

Suffixes BCD to define the secondary protection tube (if any), primary protection tube, and head

Suffix E to define the length, in inches (see specific Figure);

Suffix F to specify any options: calibration, flange or bushing, or tagging

EXAMPLES

3080-S-612-24-520-206

Specifies a Type S thermocouple with IPTS 68 calibration **(3080-S)** mounted in a 1″ standard pipe size 446 SS secondary protection tube **(6□□)** and a Fyrestan primary tube **(□1□)** with a Universal Head **(□□2)**, 24″ long **(24)**, with a 1″ NPT bushing **(5□□)** welded to the secondary tube 20″ from the hot end **(□20)**. A linen tag **(206)** is also included, wired to the assembly (specify legend)

Replacement Element: 3080-S-002-24-000. Note that Suffix D **(2)** must be included to specify the correct element.

Replacement Primary Tube: 3080-S-010-24-000.

Replacement Secondary Tube: 3080-S-600-24-520.

A BCD E F
Assembly Catalog Number: **308☐–☐–☐☐☐–☐☐–☐☐☐**

A BCD E F
Replacement Element: **308☐–☐–0 0 ☐–☐☐–☐☐☐**

A BCD E F
Replacement Primary Tube: **308☐–0– 0 ☐ 0–☐☐–☐☐☐**

A BCD E F
Replacement Secondary Tube: **308☐–0– ☐ 0 0–☐☐–☐☐☐**

	Description					Suffix
Base Number: Calibration	IPTS-68 Calibration IPTS-48 Calibration (Type S or R Only)					**3080** **3081**
Suffix A: Type of Thermocouple	None (Specified When Ordering Replacement Tubes) Type S (Platinum, 10% Rhodium-Platinum); 2700 F, Max. Type R (Platinum, 13% Rhodium-Platinum); 2700 F, Max. Type B (Platinum, 30% Rhodium-Platinum, 6% Rhodium); 3100 F, Max.; Requires Alumina Primary Tube					**0** **S** **R** **B**
Suffix BCD: Secondary Tube, Primary Tube, Head Assembly	Secondary Tube	Primary Tube		Head	Fig	
	None (Specified When Ordering Replacement Element)					**000**
	None	Fyrestan ¼" ID × ⅜" OD (2800 F, Max.)	With 2" Brass Sleeve, ⅞-27 Thread	Open-Terminal Cast Iron	A B	**081** **082**
		Fyrestan, 7/16" ID × 11/16" OD (2800 F, Max.)	With 2" Brass Sleeve, ⅞-27 Thread	Open-Terminal Universal	A B	**011** **012**
			With 6" Inconel Sleeve, ¾" NPT Thread	Universal	C	**042**
			With ¾" NPT SS Mounting Bushing	Universal	D	**062**
		Alumina, 7/16" ID × 11/16" OD (3400 F, Max.)	With 2" Brass Sleeve, ⅞-27 Thread	Open-Terminal Universal	A B	**021** **022**
			With 6" Inconel Sleeve, ¾" NPT Thread	Universal	C	**052**
			With ¾" NPT SS Mounting Bushing	Universal	D	**072**
	Silicon Carbide, 1" ID × 1¾" OD, With Collar 3" OD × 1" (3000 F, Max.)*	Fyrestan, 7/16" ID × 11/16" OD, With 2" Brass Sleeve, ⅞-27 Thread		Open-Terminal Universal	E F	**111** **112**
		Alumina, 7/16" ID + 11/16" OD, With 2" Brass Sleeve, ⅞-27 Thread		Open-Terminal Universal	E F	**121** **122**
	Fyrestan, 1" ID × 1¼" OD, With 2¼" Steel Sleeve, 1" NPT Female Thread	Fyrestan, 7/16" ID × 11/16" OD, With 2" Brass Sleeve, ⅞-27 Thread		Open-Terminal Universal	G H	**211** **212**
	Alumina, 1" ID × 1¼" OD, With 2¼" Steel Sleeve, 1" NPT Female Thread	Alumina, 7/16" ID × 11/16" OD, With 2" Brass Sleeve, ⅞-27 Thread		Open-Terminal Universal	G H	**321** **322**
	Metal-Ceramic (77% Cr-23% AlO_2), ⅝" ID × ⅞" OD, With ¾" Conduit Thread (2500 F, Max)	Fyrestan, ¼" ID × ⅜" OD, With 2" Brass Sleeve, ⅞-27 Thread		Open-Terminal Universal	I J	**433** **434**
	Inconel, 1" Std Pipe Size (2100 F, Max)	Fyrestan, 7/16" ID × 11/16" OD, With 2" Brass Sleeve, ⅞-27 Thread		Universal	K	**512**
	Inconel, ½" Std Pipe-Size	Fyrestan, ¼" ID × ⅜" OD, With 2" Brass Sleeve, ⅞-27 Thread		Universal	L	**782**
	446 Stainless Steel, 1" Std Pipe Size (2000 F, Max)	Fyrestan, 7/16" ID × 11/16" OD, With 2" Brass Sleeve, ⅞-27 Thread		Universal	K	**612**
	446 Stainless Steel, ½" Std Pipe Size	Fyrestan, ¼" ID × ⅜" OD, With 2" Brass Sleeve, ⅞-27 Thread		Universal	L	**882**

[illegible]

Continued page 39

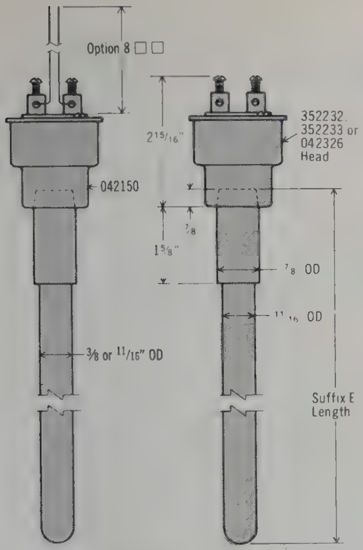

Option 8 ☐☐
2¹⁵⁄₁₆"
352232, 352233 or 042326 Head
042150
⅞
1⅝"
⅞ OD
¹¹⁄₁₆ OD
⅜ or ¹¹⁄₁₆" OD
Suffix E Length

Figure A

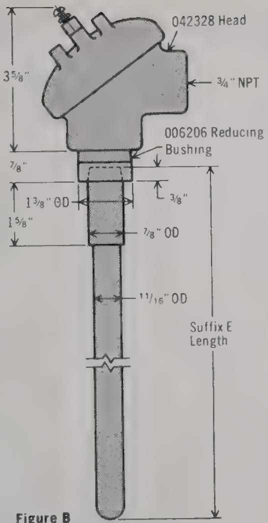

042328 Head
3⅝"
¾" NPT
006206 Reducing Bushing
⅞"
1⅜" OD
⅜"
1⅝"
⅞" OD
¹¹⁄₁₆" OD
Suffix E Length

Figure B

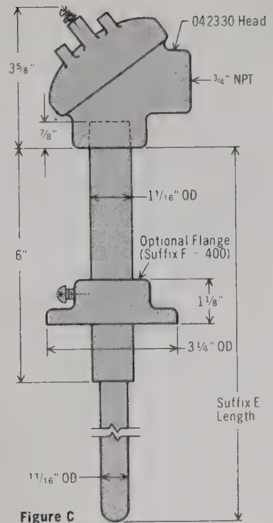

042330 Head
3⅝"
¾" NPT
⅞"
1¹⁄₁₆" OD
Optional Flange (Suffix F = 400)
6"
1⅛"
3¼" OD
Suffix E Length
¹¹⁄₁₆" OD

Figure C

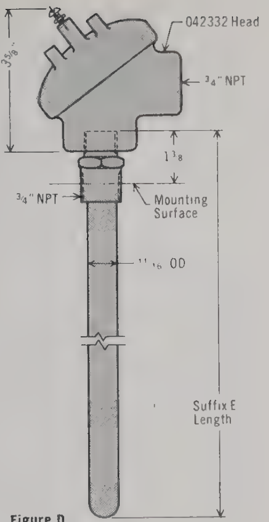

042332 Head
3⅝"
¾" NPT
1⅛
¾" NPT
Mounting Surface
¹¹⁄₁₆ OD
Suffix E Length

Figure D

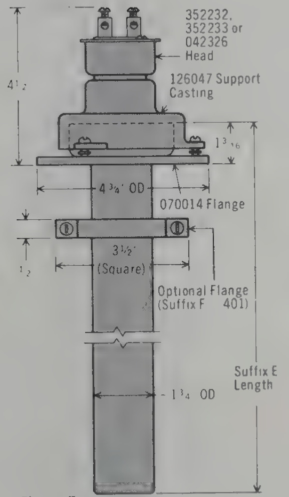

352232, 352233 or 042326 Head
4½
126047 Support Casting
1³⁄₁₆
4¾" OD
070014 Flange
½
3½" (Square)
Optional Flange (Suffix F = 401)
Suffix E Length
1¾ OD

Figure E

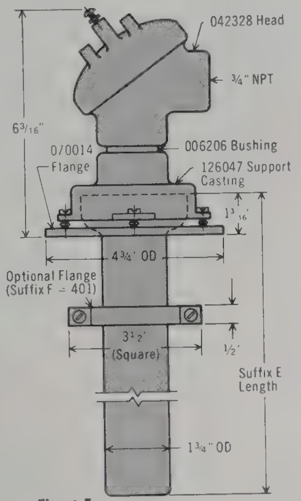

042328 Head
¾" NPT
6³⁄₁₆"
070014 Flange
006206 Bushing
126047 Support Casting
1³⁄₁₆
4¾" OD
Optional Flange (Suffix F = 401)
3½" (Square)
½"
Suffix E Length
1¾" OD

Figure F

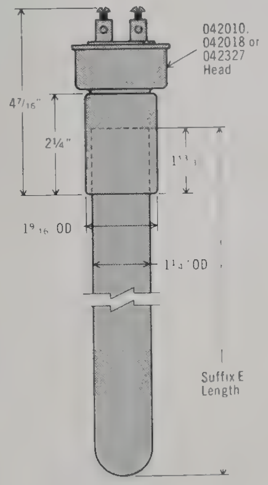

042010, 042018 or 042327 Head
4⁷⁄₁₆"
2¼"
1¹¹⁄₁₆
1⁹⁄₁₆ OD
1¼" OD
Suffix E Length

Figure G

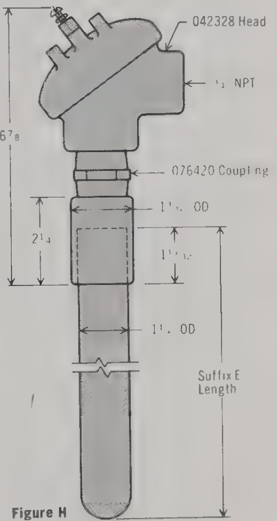

042328 Head
¾ NPT
6⅞
076420 Coupling
1¹¹⁄₁₆ OD
2¼
1¹¹⁄₁₆
1¼ OD
Suffix E Length

Figure H

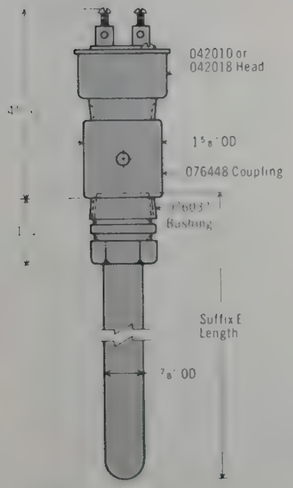

042010 or 042018 Head
4
1⅝" OD
076448 Coupling
076037 Bushing
1
Suffix E Length
⅞" OD

Figure I

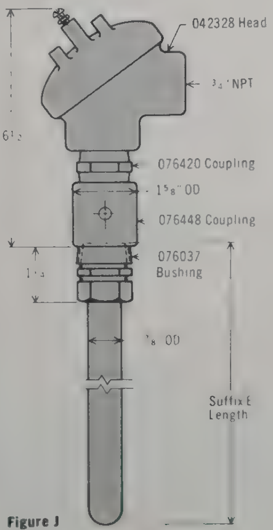

042328 Head
¾" NPT
6½
076420 Coupling
1⅝" OD
076448 Coupling
076037 Bushing
1¼
⅞ OD
Suffix E Length

Figure J

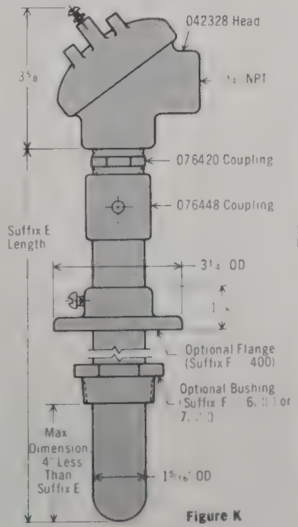

042328 Head
3⅝
¾ NPT
076420 Coupling
076448 Coupling
Suffix E Length
3¼ OD
1⅛
Optional Flange (Suffix F = 400)
Optional Bushing (Suffix F = 6 or 7)
Max Dimension 4" Less Than Suffix E
1⁵⁄₁₆" OD

Figure K

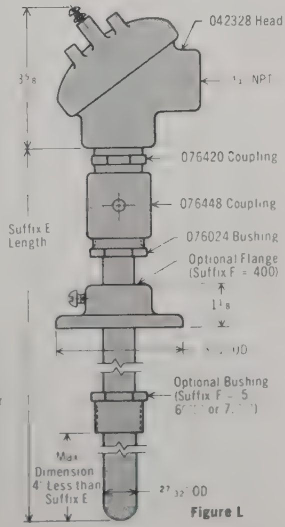

042328 Head
3⅝
¾ NPT
076420 Coupling
076448 Coupling
Suffix E Length
076024 Bushing
Optional Flange (Suffix F = 400)
1⅛
OD
Optional Bushing (Suffix F = 5 6 or 7)
Max Dimension 4" Less than Suffix E
²⁷⁄₃₂" OD

Figure L

	Description			Suffix
Suffix E: Length	Nominal Thermocouple Length, in Inches (Minimum, 12"; Maximum, 36"). See Appropriate Figure.			
Suffix F: Options	None			000
	Calibration Check(s): Correction Data Supplied for Any Specified Points Between 33 and 3000 F	Correction Data Supplied on Linen Tag		300
		Correction Data Supplied in Typed Report, Plus Tag		301
	L&N Report of Calibration (Correction to IPTS 68)**	EMF vs Temperature in One Degree Celsius Intervals Over Range of 0 to 1450 C		302
		EMF vs Temperature in One Degree Fahrenheit Intervals Over Range of 32 to 2650 F		303
	Adjustable Flange	Clamps to Inconel Sleeve of Primary Tube (Fig. C) or to Metal Secondary Tube (Fig. K or L)	Cast-Iron Flange With Locking Screw, 3¼" OD	400
		Clamps to Silicon Carbide Secondary Tube (Fig. E or F)	Brass Casting, Two-Piece Spring Type, With Locking Screws, Nuts, Asbestos Lining; ½" Long × 2⅜" Square	401
	Steel Bushing, Welded to Metal Secondary Tube. Specify (in Blanks) the Distance in Inches from Hot End of Tube to Underside of Bushing. (Maximum Dimension is 4" Less Than Suffix E.)	1" NPT, Applicable to Fig. L		5☐☐
		1¼" NPT, Applicable to Fig. K or L		6☐☐
		1½" NPT, Applicable to Fig. K or L		7☐☐
	Ice Bath Lead Extension—Specify Length in Inches (For Use with Suffixes 011, 018 Only)			8☐☐
	Universal-Head Conduit Adapter	Converts Cast-Iron Head ¾" NPT Conduit Opening for ½" NPT Conduit		131
	Grounding Connection	Ground Screw Provided Inside Cast-Iron Universal Head for Drain Wire in Conduit Cable		150
	Tagging	1 Linen Tag (Specify Legend)		206
		1 Aluminum Tag, Machine-Stamped, 15 Characters Max. (Specify Legend)		207
		1 Stainless Steel Tag, Electro-Etched, 22 Characters Max. on Each of Three Lines (Specify Legend)		208

***Applicable to Catalog 3080-S (IPTS 68, Type S) assemblies only with minimum length 24", maximum length 36"*

REPLACEMENT HEADS AND FITTINGS

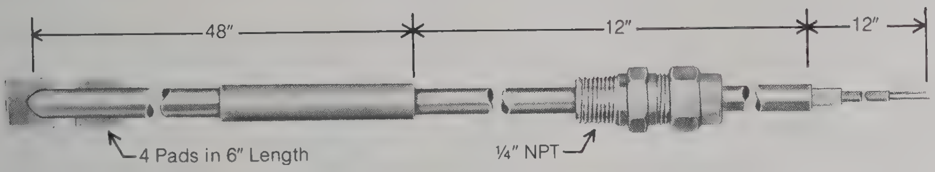
Assembly		Head		Assembly Fittings
Figure	Suffix BCD	Type	Part Number	
A	011, 021	Open-Terminal*	Type S: 352232 Type R: 352233 Type B: 042326	—
B	012, 022	Universal**	042328	006206 Reducing Bushing
C	042, 052	Universal**	042330	
D	062, 072	Universal**	042332	—
E	111, 121	Open-Terminal*	Type S: 352232 Type R: 352233 Type B: 042326	126047 Support Casting 096069 Gasket 070014 Flange
F	112, 122	Universal**	042328	006206 Reducing Bushing 126047 Support Casting 096069 Gasket 070014 Flange
G	211, 321	Open-Terminal*	Type S: 042010 Type R: 042018 Type B: 042327	
H	212, 322	Universal**	042328	076420 Coupling
I	433	Open-Terminal*	Type S: 042010 Type R: 042018	076448 Coupling 076037 Bushing
J	434	Universal**	042328	076420 Coupling 076448 Coupling 076037 Bushing
K	512, 612	Universal**	042328	076420 Coupling 076448 Coupling
L	782, 882	Universal**	042328	076420 Coupling 076448 Coupling 076024 Bushing

[illegible]

[illegible] tapped ½" NPT for 042332 Head, ¾" NPT for 042330 Head, and 1" NPT for 042328 Head

8789 Thermocouple Assembly

for Superheater Tube Temperature



The 8789-Series Thermocouple Assemblies are designed for temperature measurements on individual superheater and reheater tubes. Since these measurements are normally made in a vestibule located on top of the boiler — above the boiler roof and away from the high-velocity, high-temperature gases but within the boiler casing — compacted-ceramic thermocouple construction, supplied with suitable welding pads, is well-suited to the normal 1000 to 1100 F range of tube temperatures. In addition, this construction offers maximum protection against the products of combustion found in the vestibule gases.

The 8789 Assembly consists of 16 AWG thermocouple wire in compacted-ceramic insulation, enclosed in a 304 stainless-steel sheath 5/16″ OD, 48″ long, with 20 AWG extension leadwire, 12″ long. Both the thermocouple element and extension leadwire are sealed against moisture and contamination.

Four curved welding pads, shaped for welding to 2″ to 4″ OD tubes, are provided — one located over the tip of the thermocouple element, the others positioned close to the first pad.

The 20 AWG leadwire is insulated with silicone-impregnated fiberglass over the individual wires and fiberglass braid overall, and is encased in a ¼″ OD steel tube. Twelve inches of insulated leadwire project beyond the end of the tube. A compression fitting with ¼″ NPT mounting thread is provided for gas-tight installation in the boiler casing.

Upper temperature limit of the thermocouple is 1600 F; of the leads, 1000 F.

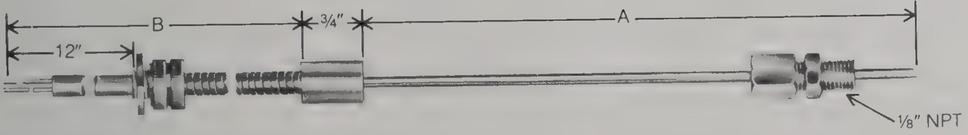
HOW TO ORDER To order an 8789 Assembly with 48″ element and 12″ leadwire extension (suffix "60"), specify 8789-J-60 for an iron-constantan element, 8789-K-60 for a nickel, chromium-nickel, aluminum element, or 8789-E-60 for a nickel, chromium-constantan element.

To specify any of these assemblies with an extension greater than 12″ (to a maximum of 780″, in 12″ increments), add the extension length to the 48″ element length, and substitute for suffix "60" (e.g., a 48″ iron-constantan element with 36″ extension would be ordered as 8789-J-84).

If a terminal connector is required on the assembly, an 042191 Universal Head (aluminum) and an 076526 Compression Fitting can be separately ordered, for mounting on the end of the leadwire tube.

8794 Thermocouple Assembly

for Turbine Casing Temperatures



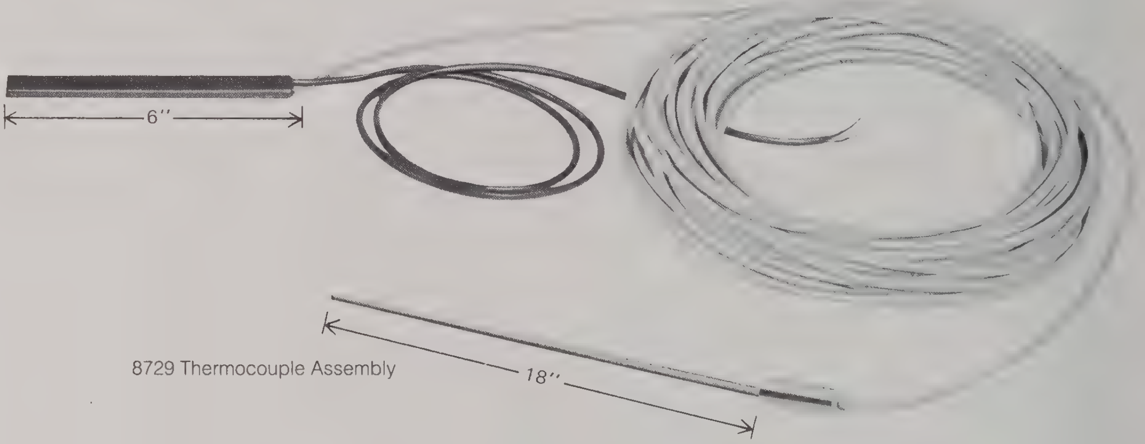
The 8794 Thermocouple Assembly comprises a 20 AWG thermocouple element grounded in a ⅛″ OD 304 stainless-steel protecting tube, with a stainless-steel compression fitting, ⅛″ NPT. The tube terminates in a fitting to anchor one end of a 17/64″ OD 304 stainless-steel flexible tubing (enclosing the 20 AWG leadwires); the other end of the tubing is equipped with a cable grip (⅜″ NPT) and nut for attaching the leadwire assembly to a junction box. Standard length of the element is 7″; of the leadwire, 4′ (including 1′ extending beyond the cable grip). Other lengths can be supplied.

HOW TO ORDER To order an iron-constantan (Type J) thermocouple assembly, specify Catalog Number 8794-1-☐-☐, where the first suffix is the element length in inches (dimension "A") and the second suffix is the length of the extension wire in feet (dimension "B"). For example, 8794-1-7-4 has a 7″ element and 4′ leads

To order a nickel, chromium-nickel, aluminum (Type K) assembly, specify Catalog Number 8794-2-☐-☐, with appropriate suffixes.

8729 Thermocouple Assembly

For Turbine Acceptance Testing



8729 Thermocouple Assembly

This assembly was constructed by L&N to meet the requirements of the ASME Power Test Code for steam and water temperature measurements up to 1600 F on turbine acceptance tests and provides an ideal combination of accuracy and convenience.

Element Type E (20 AWG Premium grade) 77 ft. long.

Measuring End First 18½″ of thermocouple encased in ¼″ OD, 0.180″ ID, Type 304 stainless steel protection tube. Measuring junction is welded into tip of closed end. (Lengths to 10″ in stainless steel protection tube available.) Stainless steel adapter joins protection tube to leadwire.

Insulation First 19″ of each wire is porcelain insulated and encased in steel tubing. Remaining 75′-5″ with thermolastic elastomeric rubber on individual conductors and overall jacket, runs to ref. junction.

Reference Junction Last 6″ of wire and cold junction are encapsulated in epoxy for ice bath immersion. A 6 ft length of #18 2-conductor copper wire with stranded cotten and rubber insulation and synthetic to connect the thermocouple to a measuring potentiometer.

Temperature Limit (1600 F) 871.11 C, maximum.

Limit of Error ±⅜% at (1200 F) 648.89 C.

Cable Specifications Temperature Rating −65 C (−85 F) to +125 C (+257 F). Highly flame resistant, self-extinguishing compound that meets the limits of the UL FR-1 Flame Test Procedure and IEEE 383 Vertical Flame Test. Environmental resistance to weather, oil and ozone.

HOW TO ORDER

To order an assembly as described specify

A B C
8729-E-75-000

In sequence, the catalog number comprises:

A base number (8729) to define thermocouple assembly

Suffix A to define the type of thermocouple element

Suffix B to define the thermocouple cable length between measuring end and reference junction.

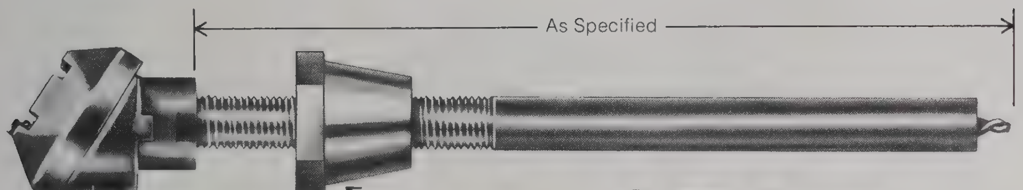
Suffix C To specify any options: calibration or tagging

A B C
Assembly catalog number **8729-E-☐-☐**

	Description		Suffix
Suffix A Thermocouple Type	Nickel, Chromium—Constantan		E
Suffix B Cable Length	Specify length in feet (75 ft standard)		☐
	None		000
	Tagging	1 Linen Tag (Specify Legend)	206
		1 Aluminum Tag, Machine-Stamped, 15 Characters Max. (Specify Legend)	207
		1 Stainless-Steel Tag, Electro-Etched, 22 Characters Max. on Each of Three Lines (Specify Legend)	208
Suffix C Options	Calibration	Calibration Check(s)	
		Correction Data Supplied on Linen Tag	300
		Correction Data Supplied in Typed Report, plus Linen Tag	301

8766 Open-End Thermocouple Assembly

for Blast Furnace Temperatures



8766 Thermocouple Assembly

8745
Thermocouple
Mounting

Designed for continuous measurement of blast-furnace temperatures, the 8766 Assembly consists of 8 AWG nickel, chromium-nickel, aluminum wires in two-hole insulators, mounted in a ¾″ std open-end Inconel tube with an 042190 Universal Head (aluminum). The Inconel (80% nickel, 15% chromium) tube has a 9-inch length of ¾″ std Yoloy pipe, with a 6″ running thread, welded to the "cold" end. Both ends of the tube are sealed for a length of approximately 2″ with refractory material, with the measuring junction of the thermocouple extending ½″ beyond the "hot" end. A 500095 Tapered Plug is threaded on the cold end to permit adjustable insertion. Maximum insertion is 2″ less than the length specified; minimum insertion, 6″ less.

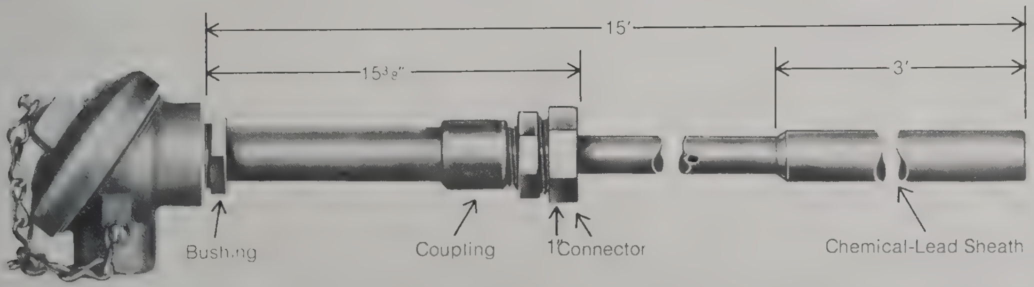
Mounting Accessory: The 8745 Thermocouple Mounting is fastened to the hot-blast main, and has a tapered hole to accept the tapered plug of the 8766 thermocouple and a locking key to anchor the plug in place. Weight, about 36 lb.

HOW TO ORDER To specify an 8766 Assembly, add the length of the protecting tube (in inches) as a suffix to the catalog number; e.g., an assembly with a 24-inch tube would be 8766-24. Assemblies are available in lengths from 12″ to 36″, in 6″ increments.

For a replacement element (sealed into a tube), order an 8766-☐☐-S, specifying the appropriate length as a suffix and the omission of the Head and Tapered Plug.

To specify an 8745 Mounting, add the diameter of the main in inches (34″ minimum, 84″ maximum) as a suffix to the catalog number; e.g., 8745-40 for a mounting for a 40″ main.

8727 Thermocouple Assembly for Pickling Acid Temperatures

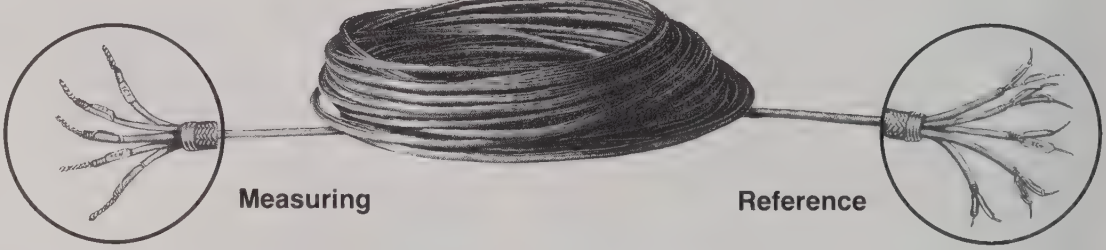


The 8727 Thermocouple Assembly is recommended for use at temperatures up to 500 F in pickling acids, which remove scale from iron and steel products prior to galvanizing or other coating operations. The assembly consists of lead-covered 14 AWG iron and constantan wires, with the measuring-junction end of the thermocouple protected by an additional chemical-lead sheath 3′ long. It has a lead-sleeve connector, an iron coupling and extension, reducing bushings and a 352237 Universal Head (cast iron). Length, from head to tip, is 15′

HOW TO ORDER To order, simply specify Catalog Number 8727

8799-5 5-Junction Cable-Type Multiple Thermocouple

for Checking Temperature Uniformity in Continuous Ovens



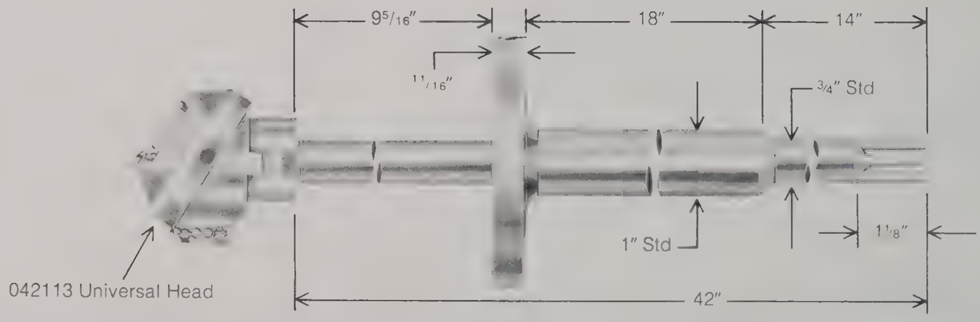
The 8799-5 Multiple Thermocouple is used as a traveling thermocouple for checking temperatures up to 500 F in continuous ovens, such as lithographing ovens in can manufacturing. It consists of 5 pairs of 20 AWG iron-constantan (Type J) wires, with fiberglass insulation on each wire, fiberglass braid on each twisted pair, and fiberglass braid and braided 304 stainless-steel wire overall.

At the measuring end, the stainless steel and fiberglass braid on each pair are removed for a length of 24", and the ends are welded to form five iron-constantan junctions. At the reference end, the wire and braid on each pair are removed for a length of 9"; the pairs and individual wires are tagged to designate thermocouple numbers and polarity.

HOW TO ORDER To specify a complete cable-type assembly, add the length in feet as a suffix to the catalog number; e.g., a 100-ft cable is ordered as 8799-5-100. Telephone clips can be provided at the reference ends as an added-cost option. To order cable only — no junctions, no tagging — specify the required length of Part Number 20-52-1 (stocked for immediate delivery).

8955 and 18956 Thermocouple Assemblies

For Ammonia Oxidation Process



These thermocouples are used in controlling the ammonia-oxidation process, which takes place in a high-pressure chamber filled with ammonia and nitrous oxide and operates at 1000 C. During the reaction, hot gases pass through a fine-gauge platinum catalyst whose temperature must be controlled at a safe level by this fast-acting thermocouple sensor, to prevent its destruction

The assembly consists of a 10% rhodium, platinum-platinum (Type S) or a nickel, chromium-nickel, aluminum (Type K) element with compacted-ceramic insulation in an Inconel sheath, mounted in a protection tube with an aluminum Universal Head

The protection tube (high-temperature Inconel 600, ¾" std) has an 18" sleeve (347 stainless steel, 1" std) welded to it, with a mounting flange (347 stainless steel, 1½", 150 lb, R.F.) welded to the sleeve. The thermocouple element projects 1⅛" from the sealed "hot end" of the protection tube; three extension rods protect the element from damage

HOW TO ORDER To order an assembly with a Type S (IPTS 68) element, specify Catalog Number 18956. For an assembly with a Type K element, specify Catalog Number 8955

Thermocouple Wires

Standardized thermocouple wires, bare and insulated, are available in a number of sizes. All are manufactured to rigid specifications, to obtain the desired chemical, physical and electrical properties. Sample sections are cut from each reel, made into couples, and carefully tested for accuracy of calibration.

The wires listed below and on the following pages can be used, in the proper combinations, to make thermocouples which will match the millivolt-temperature tables within the "Standard Limits of Error," which are narrow enough for industrial purposes.

For applications where it is advantageous to know actual deviations from established characteristics, combinations of wires can be tagged with correction data which apply at specific temperatures. (See "Thermocouple Accuracy," page 3.)

Where it is desirable to have unusual accuracy in base-metal thermocouples, certain premium-grade Type J and K insulated duplex thermocouple wires (and extension wires) are listed which meet the "Special Limits of Error".

Only commonly-used insulations are listed, but wires with special insulation can be supplied. (For recommendations, see the table "Insulation Characteristics" on page 48.)

To assist those who make their own thermocouples, we offer Direction Book 077987, "Thermocouple Welding", which describes in detail the procedures used or recommended by Leeds & Northrup. We also suggest the use of Quiktip Tools and Connectors as a convenient, inexpensive technique for forming base-metal thermocouple junctions (see page 59).

With the exception of certain bare wires for platinum thermocouples, all listed wires are normally available for delivery from stock.

LIMITS OF ERROR

ANSI Type	Type of Thermocouple	IPTS	Temperature Range	Limits of Error* Standard	Limits of Error* Special
J	Iron and Constantan	68**	−310 to −100 F	—	±2%
			−100 to +600 F	±4 F	±2 F
			600 to 800 F	±4 F	±1/3%
			800 to 1400 F	±3/4%	±1/3%
K	Nickel, Chromium and Nickel, Aluminum	68**	32 to 530 F	±4 F	±2 F
			530 to 2300 F	±3/4%	±3/8%
T	Copper and Constantan	68**	−300 to −75 F	—	±1%
			−150 to 75 F	±2%	±1%
			−75 to +200 F	±1½ F	±3/4 F
			200 to 700 F	±3/4%	±3/8%
N	Nicrosil-Nisil	68	32-530°F	4°F	
			530-2300°F	3/4%	—
E	Nickel, Chromium and Constantan	68**	32 to 600 F	±3 F	±2 F
			600 to 1600 F	±½%	±3/8%
S	Platinum, 10% Rhodium and Platinum	68	0 to 1000 F	±2.5 F	±1.5 F†
			1000 to 2700 F	±0.25%	±0.15%†
		48	0 to 1000 F	±5 F††	±2.5 F
			1000 to 2700 F	±0.5%††	±0.25%
R	Platinum, 13% Rhodium and Platinum	68	0 to 1000 F	±2.5 F	—
			1000 to 2700 F	±0.25%	—
		48	0 to 1000 F	±5 F††	±2.5 F
			1000 to 2700 F	±0.5%††	±0.25%
B	Platinum, 30% Rhodium and Platinum, 6% Rhodium	68	1600 to 3100 F	±½%	—

*When expressed as a percentage, the limit of error is a percentage of the temperature reading, not of the range

**L&N wires, elements, etc. listed for these base-metal thermocouples can be used with instruments having scales calibrated to match either IPTS-68 or IPTS-48

†These limits of error apply only to the 24 AWG platinum wire (24-1-6) and the 24 AWG platinum, 10% rhodium wire (24-1-63)

††These limits of error apply only to the 24 AWG platinum wire (24-1-29), 24 AWG platinum, 10% rhodium wire (24-1-30) and the 24 AWG platinum, 13% rhodium wire (24-1-56)

HOW TO ORDER

Specify Wire Number and quantity required.

BARE WIRES FOR PLATINUM, RHODIUM-PLATINUM THERMOCOUPLES

AWG	Diameter, Inches	Part Number							
		Platinum		Platinum, 10% Rhodium		Platinum, 13% Rhodium		Platinum, 30% Rhodium, IPTS 68	Platinum, 6% Rhodium, IPTS 68
		IPTS 68	IPTS 48	IPTS 68	IPTS 48	IPTS 68	IPTS 48		
24	0.0201	*801224	*801011	801222	*801007	801223	801046*	801195	801196
24	0.0201	*801011†	*801116††	801219	*801117††	—	*801194††	—	—

*Stock wires.

†Meets Special Limits of Error for IPTS 68 reference-grade wire, all other IPTS 68 wires meet Standard Limits of Error

††Meets Standard Limits of Error for IPTS 48 wire ("Grade B"); all other IPTS 48 wires meet Special Limits of Error ("Grade A")

BARE WIRES FOR BASE-METAL THERMOCOUPLES

AWG	Diameter, Inches	Nickel, Chromium (EP, KP) Part Number	Nickel, Chromium (EP, KP) Ft/Lb (Approx.)	Nickel, Aluminum (KN) Part Number	Nickel, Aluminum (KN) Ft/Lb (Approx.)	Copper (TP) Part Number	Copper (TP) Ft/Lb (Approx.)	Constantan for Copper or Nickel, Chromium (EN, TN) Part Number	Constantan for Copper or Nickel, Chromium (EN, TN) Ft/Lb (Approx.)	Nicrosil (NP) Part Number	Nicrosil (NP) Ft/Lb (Approx.)	Nisil (NN) Part Number	Nisil (NN) Ft/Lb (Approx.)
6	0.1620	—	12.9	—	12.5	—	—	—	—	—	—	—	
8	0.1285	801036	20.8	801033	20	801086	22	801238	20	801313	20.8	801321	20
14	0.0640	801035	82.3	801034	80	801078	80	801071	80.6	801314	82.3	801322	80
16	0.0508	801132	130	801133	127	801177	127	801037	127	801315	130	801323	127
18	0.0403	801262	210	801263	200	—	205	—	206	801316	210	801324	200
20	0.0320	801013	328	801029	325	801001	325	801005	322	801317	328	801325	325
22	0.0253	—	526	—	500	—	—	—	—	801318	526	801326	500
24	0.0201	801108	831	801031	805	801025	820	801004	817	801319	831	801327	805
30	0.0100	801192	3324	801193	3220	801024	3450	801003	3300	801320	3324	801328	3220

Thermocouples | Assemblies for Specialized Applications

BARE WIRES — (MATCHED CONDUCTORS) FOR BASE MC

		Iron (JP)*		Constantan* for Iron (JN)	
AWG	Diameter, Inches	Part Number	FT/LB	Part Number	FT/LB
8	0.128	801295	22.7	801304	20.1
14	0.0640	801296	91.2	801305	80.6
16	0.0508	801297	144	801306	127
18	0.0403	—	233	—	206
20	0.0320	801298	365	801307	322
22	0.0253	—	—	—	—
24	0.0201	801299	926	801308	817
30	0.0100	801300	37.4	801309	3300

*Should be ordered in equal lengths of each wire as the present supply may not match the EMF US temperature relationship of the type J curve when mixed with wire supplied prior to Nov. 1980

INSULATED WIRES FOR BASE-METAL THERMOCOUPLES — Single Wires

		Insulation			
		Enamel		Enamel & Single Cotton Cover	
Wire	AWG	Wire Number	Ft/Lb (Approx.)	Wire Number	Ft/Lb (Approx.)
Iron (JP)	20 30	— 838008	— 3400	— 838005	— 3250
Constantan For Iron (JN)	20 30	— 840013	— 3300	— 840012	— 2850
Copper (TP)	20 24 30	— 832001 832002	— 810 3300	— — 832008	310 — 2850
Constantan For Copper (TN)	20 30	— —	— —	— 842019	— 2850

Duplex Wires — Solid Conductors

Wires	Insulation		AWG	Overall Size (In.)	Ft/Lb (Approx.)	Wire Number
	On Each Wire	Overall				
Type J (Iron and Constantan)	Synthetic Fiber Insulation	Glass Braid, Silicone Impregnated	20 24	0.065 × 0.095 0.055 × 0.070	135 300	**850043** **850044**
	Extruded Nylon	Extruded Nylon	24	0.050 × 0.085	300	**850016**
	Double-Glass Wrap, Silicone-Impregnated	Glass Braid, Silicone Impregnated	20 24 30	0.062 × 0.108 0.044 × 0.072 0.033 × 0.054	115 240 460	**850007** **850008** **850009**
	Glass Fiber, Silicone-Impregnated	Glass Braid, Silicone-Impregnated; Stainless Steel Overbraid	16	0.168 × 0.20	25	**850023****
	Polyvinyl	Polyvinyl	20	0.110 × 0.170	172	**850025**
	Teflon (FEP)	Teflon (FEP)	20	0.075 × 0.130	100	**850026**
Type T (Copper and Constantan)	Enamel; Double-Glass Wrap; Moisture and Heat-Resistant Compound	Glass Braid; Moisture and Heat-Resistant Compound	20 24 30	0.062 × 0.108 0.044 × 0.072 0.033 × 0.054	115 240 460	**855004** **855003** **855002**
	Double-Glass Wrap, Silicone-Impregnated	Glass Braid, Silicone-Impregnated	24	0.045 × 0.070	300	**855005*****
	Polyvinyl	Polyvinyl	20	0.110 × 0.170	160	**855015**
	Polymide Double Cotton Cover	None; Twisted Pair	28	0.050 dia.	1200	**855009**
	Teflon (FEP)	Teflon (FEP)	20	0.072 × 0.124	100	**855016**
Type E (Nickel, Chromium-Constantan)	Thermoelastic Rubber Twisted Pair	Thermoelastic Rubber	20	0.250 dia.	35	**864001**
	Polyvinyl	Polyvinyl	20	0.110 × 0.170	160	**864007**
	Teflon (FEP)	Teflon (FEP)	20	0.075 × 0.130	100	**864008**
	Double-Glass Wrap, Silicone-Impregnated	Glass Braid, Silicone-Impregnated	24 20	0.044 × 0.072 0.062 × 0.108	240 115	**864040** **864002**

**Primarily for boiler tube applications, 1000 F and below

***High-accuracy wire, specially selected to a limit of error of ± 1/4°, F when hot junction is at 175 F and reference junction is at 32 F

Continued

Duplex Wires — Solid Conductors — *Continued*

Wires	Insulation		AWG	Overall Size (In.)	Ft/Lb (Approx.)	Wire Number
	On Each Wire	Overall				
Type K (Nickel, Chromium-Nickel, Aluminum)	Silicone-Impregnated Synthetic Fiber	Single-Glass Braid, Silicone-Impregnated	20	0.060 × 0.095	125	**858069**
	Silicone-Impregnated Synthetic Fiber	Synthetic Fiber, Silicone Impregnated	20	0.150 × 0.215	60	**858070**
	Double-Glass Wrap, Silicone-Impregnated	Single-Glass Braid, Silicone-Impregnated	20 20 24 30 30	0.062 × 0.108 0.062 × 0.108 0.044 × 0.072 0.030 × 0.048 0.030 × 0.048	125 125 300 700 700	**858004** **858014*** **858022** **858023** **858015***
	High-Temperature Silica Wrap (Fibrefrax)	High-Temperature Silica Braid (Refrasil)	20	0.100 × 0.166	74	**858005**
	Double-Glass Wrap, Silicone-Impregnated	Double-Glass Braid, Silicone-Impregnated	20	0.062 × 0.108	120	**858006**
	Teflon (FEP)	Teflon (FEP)	20	0.072 × 0.124	100	**858017**
Type N Nicrosil-Nisil	Double Glass Wrap Silicone-Impregnated	Single Glass Wrap Silicone-Impregnated	20	0.055 × 0.090	125	**893001**
	Teflon (FEP)	Teflon (FEP)	20	0.075 × 0.130	100	**893002**
	Polyvinyl	Polyvinyl	20	0.110 × 0.170	160	**894001**

**These premium-grade wires have been selected to match the temperature-emf curves within the "Special Limits of Error". Minimum order for any one type is 200 feet*

Multiple Wires, 4- and 5-Pair

Wire	Insulation			AWG	Overall Size (In.)	Ft/Lb (Approx.)	Wire Number
	On Each Wire	On Each Pair	Overall				
Type J (Iron and Constantan), 5-Pair	Glass Braid, Silicone-Impregnated	Glass Braid, Silicone-Impregnated	Glass Braid, Silicone-Impregnated & Braided Steel Armor	20	0.350 dia	12	**852001**
Type J (Iron and Constantan) 4-Pair	Polyvinyl	4 Pair Twisted	Al Mylar, Braid, Polyvinyl	20	0.400 dia.	10	**852003**
Type K (Nickel, Chromium-Nickel, Aluminum) 4-Pair	Polyvinyl	4 Pair Twisted	Al Mylar, Braid, Polyvinyl	20	0.400 dia.	10	**858013**

ISA COLOR CODE — DUPLEX THERMOCOUPLE WIRES

Thermocouple	Wire Insulation Color Code		
	Positive (+)	Negative ( )	Overall
Iron-Constantan (J) Nickel, Chromium-Nickel, Aluminum (K) Copper-Constantan (T) Nickel, Chromium-Constantan (E) Nicrosil-Nisil (N)	Iron: White Nickel, Chromium: Yellow Copper: Blue Nickel, Chromium: Purple Nicrosil: Orange	Constantan: Red Nickel, Aluminum: Red Constantan: Red Constantan: Red Nisil: Red	Brown

WIRE RESISTANCE

AWG	Diameter, Inches	NOMINAL RESISTANCE, OHMS PER FOOT AT 20 C (68 F)							
		Nickel Aluminum	Nickel Chromium	Constantan	Copper	#11 Alloy	Iron	Platinum	Platinum 10% Rhodium
6	.1620	.0067	.0162	.0112	.000395	.00107	.0027	.00243	.00438
8	.1285	.0107	.0257	.0179	.000628	.0017	.0043	.00386	.00697
12	0808	0270	065	0448	00159	0043	0109	0976	01761
14	.0641	.0432	.104	.0718	.00253	.0068	.0174	.0155	.0280
16	.0508	.0683	.164	.113	.00402	.0108	.0276	.0247	.0445
18	.0403	.111	.266	.184	.00648	.0175	.0446	.0399	.0719
20	0320	173	415	287	0102	0274	0699	0624	1125
22	0253	276	663	456	0161	0436	1111	0993	1790
24	.0201	.438	1.05	.728	.0257	.0693	.1767	.1578	.2847
30	0100	1.77	4.25	2.94	1032	2786	710	6344	1.144

Extension Wires

To secure the advantages of automatic reference-junction compensation, the extension wires connecting thermocouples to measuring instruments must be of the same material as the thermocouples, or of material having essentially the same temperature-emf relationship over the stated temperature range. A couple is thus, in effect, extended right to the instrument, so that the reference-junction (at the instrument terminal board) is exposed to the same ambient temperature as the compensating coil.

Extension wires are available with various insulations, chosen with a view to durability in the surroundings to which they may be exposed. The table below should provide a guide to the choice of insulation, for either thermocouple or extension wires.

INSULATION CHARACTERISTICS

Upper Temp Limit*	Lower Temp. Limit**	Insulation	Abrasion Resistance	Moisture Absorption Resistance	Remarks
2600 F	- 300 F	Braided Ceramic Fiber	Good	Fair	Resistant to most Industrial chemicals. However, it is severely attacked by Hydrofluoric Acid, Phosphoric Acid and strong Alkalies
2000 F	200 F	Magnesium Oxide, Metal Sheath	Excellent	Excellent when properly sealed	Used in L&N compacted-ceramic insulated thermocouples.
1800 F	+ 32 F	High Temperature Silica (Refrasil)	Very Poor	None	Refrasil crystallizes and stiffens above 1800 F.
1000 F	10 F	Glass Braid, Silicone Resin Impregnated	Fair up to 400 F	Fair up to 400 F	Above 400 F, abrasion and moisture-absorption resistance destroyed.
1000 F	- 32 F	Glass Braid, Moisture- and Heat-Resistant Compound	Good up to 250 F	Good up to 250 F	Above 250 F, abrasion and moisture-absorption resistance destroyed.
550 F	450 F	Kapton	Excellent	Good	Highly resistive to abrasion and radiation. Unaffected by extreme or rapid variations in temperature.
500 F	- 40 F	Silicone-Impregnated Synthetic Fiber Non Asbestos	Very Good	Good to 400 F	Replacement for asbestos. Good chemical and mildew resistance. Unaffected by most acid and alkali solutions.
500 F	+ 32 F	Asbestos, Moisture- and Heat-Resistant Compound	Fair up to 250 F	Good up to 250 F	Above 250 F, moisture-absorption resistance permanently destroyed. Limited to 500 F to prevent sulfur corrosion.
475 F	90 F	Extruded Teflon	Excellent	Excellent	Above 600 F, tends to give off small amounts of noxious vapor. Resistant to most acids and vapors. Material will soften above 480 F.
257 F	– 85 F	Thermoelastic Rubber	Very Good	Good	Resistant to ozone, heat, oil, moisture and sun
250 F	- 40 F	Extruded Nylon (Type 103)	Excellent	Good	General purpose, except for some chemical applications; should not be used in water, or high humidity.
220 F	0 F	Polyvinyl Chloride (105 C)	Very Good	Excellent	General purpose. Material will soften and flow above 225 F.
200 F	0 F	Enamel with Cotton or Silk	Fair	Enamel; Excellent	Becomes brittle and eventually disintegrates above 212 F.
195 F	40 F	Neoprene (90 C)	Excellent	Very Good	Very good resistance to oil
165 F	65 F	Heat-Resistant Rubber	Very Good	Very Good	Provides good insulation when subject to temperature, but eventually becomes hard and brittle. Not resistant to oil.
150 F	40 F	Lead Sheath	Good	Excellent	Resistant to water and corrosive fluids which do not attack lead.
200 F	40 F	Rayon, Cellulose Acetate Lacquer	Good	Good	Used as protective braid

*For some materials heat causes softening, for others, embrittlement. Materials listed will withstand higher, short-term temperatures than those shown, the upper limit is a relative figure at which continuous, long term operation may be expected.

**Low temperatures cause insulating material to stiffen and become less flexible. Insulations listed will withstand much lower temperatures than those shown, providing the wires are not flexed, this limit is a relative figure at which the wire can be considered flexible.

LIMITS OF ERROR FOR EXTENSION WIRES

Thermocouple Type	Corresponding Extension Wires		Extension-Wire Limits of Error	
	Type	Temperature Range	Standard	Special
Nickel, Chromium-Constantan (E)	Nickel, Chromium and Constantan (EX)	0 to 400 F	±3 F	—
Iron-Constantan (J)	Iron and Constantan (JX)	0 to 400 F	±4 F	±2 F
Nickel, Chromium-Nickel Aluminum (K)	Nickel, Chromium and Nickel, Aluminum (KX)	0 to 400 F	±4 F	
Copper-Constantan (T)	Copper and Constantan (TX)	–75 to 200 F	±1½ F	±¾ F
Platinum, Rhodium-Platinum (R, S)	Copper and #11 Alloy (SX)	75 to 400 F	±9 F*	—
Platinum, Rhodium-Platinum (B)	Copper and Copper	0 to 50 C 50 to 100 C	0 C 3 7 C	

*Applicable for a reference-junction temperature of 75 F only. Special limits of error are not available.

SINGLE STRANDED CONDUCTORS

Thermocouple	Wire	Insulation	Insulation OD (Inches)	AWG	Wire Number
For Noble-Metal Thermocouples	Copper	Polyvinyl	0.065	22	832379
	#11 Alloy	Cotton, Neoprene	0.105	18	849004
		Polyvinyl	0.065	22	849001
For Base-Metal Thermocouples	Copper	Polyvinyl	0.065	22	832378
	Nickel, Chromium	Polyvinyl	0.065	22	845001
	Constantan	Polyvinyl	0.065	22	841003
	Iron (Tinned)	Polyvinyl	0.065	22	839003

DUPLEX . . . STRANDED CONDUCTORS

Thermocouple	Extension Wires	Insulation		AWG	Approx. Dimensions (Inches)	ISA Code	Wire Number
		On Each Conductor	Overall				
Platinum, Rhodium-Platinum (R.S.)	Copper and #11 Alloy	Enamel, Synthetic Fiber	Synthetic Fiber Braid	16	0.167 × .260	SX16H	860018
		Heat-Resistant Rubber	Buna S or Polychloroprene	18	0.390 dia.	—	860004
Iron Constantan (J)	Iron and Constantan	Enamel, Synthetic Fiber	Synthetic Fiber Braid	16	0.167 × 0.260	JX16H	851038
Nickel, Chromium-Nickel, Aluminum (K)	Nickel, Chromium and Nickel Aluminum	Mylar Tape, Synthetic Fiber	Synthetic Fiber Braid	16	0.300 dia.	KX16H	859033
		Mylar Tape and Heat-Resistant Rubber	Synthetic Rubber	16	0.390 dia.	—	859027

DUPLEX . . . SOLID CONDUCTORS

Thermocouple	Extension Wires	Insulation		AWG	Approximate Dimensions, Inches	ISA Code	Wire Number
		On Each Wire	Overall				
Platinum, Rhodium-Platinum (R,S)	Copper and #11 Alloy	Enamel, Synthetic Fiber	Synthetic Fiber Braid	16	0.167 × .260	SX16H	860019
Iron-Constantan (J)	Iron and Constantan	Teflon, Silicone-Impregnated Synthetic Fiber	Synthetic Fiber Braid, Silicone-Impregnated	16	0.175 × .275	JX16H	851037
		Polyvinyl	Polyvinyl, Lead Sheath	16	9/32 × 3/8	JX16L	851005
		Polyvinyl	Polyvinyl	16	0.111 × 0.192	JX16M	851023
Nickel, Chromium-Nickel, Aluminum (K)	Nickel, Chromium-Nickel, Aluminum	Enamel, Silicone-Impregnated Synthetic Fiber	Sythetic Fiber Braid, Silicone-Impregnated	16	0.167 × .260	KX16H	859032
		Polyvinyl	Polyvinyl	16	0.111 × 0.192	KX16M	859017
		Teflon (FEP)	Teflon (FEP)	16	0.095 × 0.166	—	859028
Copper-Constantan (T)	Copper and Constantan	Polyvinyl	Polyvinyl	16	0.111 × 0.192	TX16M	856236

EXTENSION WIRE RESISTANCE

Extension Wire	Nominal Resistance, Ohms Per Foot			
	16 AWG	18 AWG	20 AWG	22 AWG
Nickel, Chromium & Constantan (EX)	0.277	0.450	0.702	1.119
Iron & Constantan (JX)	0.141	0.228	0.357	0.567
Nickel, Chromium & Nickel, Aluminum (KX)	0.232	0.377	0.588	0.939
Copper & Constantan (TX)	0.177	0.190	0.297	0.472
Copper & #11 Alloy (SX)	0.015	0.024	0.038	0.697

DUPLEX...STRANDED CONDUCTORS...SHIELDED, WITH DRAIN WIRE

Thermocouple	Extension Wires	ISA Code	Wire Number	Insulation		AWG	Dimensions, Inches	Weight, 100 Ft
				On Each Wire	Overall			
Iron-Constantan (J)	Iron and Constantan	16JX	**851036**	105 C PVC	Twisted with Aluminum Mylar; Includes 18 AWG Copper Drain Wire with 80 C PVC Insulation	16	0 220 dia.	3 Lb
Copper-Constantan (T)	Copper and Constantan	16TX	**856248**					
Nickel, Chromium-Constantan (E)	Nickel, Chromium and Constantan	16EX	**864039**					
Nickel, Chromium-Nickel, Aluminum (K)	Nickel, Chromium and Nickel-Aluminum	16KX	**859031**					
Platinum, Rhodium-Platinum (R, S)	Copper and #11 Alloy	16SX	**860017**					

DUPLEX EXTENSION WIRES IN CONDUIT

Dimensions of duplex extension wires are included with their listings. Data on the approximate number of 16 AWG extension wires which can be run in conduit of a given size are given in the table below.

Wire Insulation	Size of Conduit (Inches)												
	1/2	3/4	1	1-1/4	1-1/2	2	2-1/2	3	3-1/2	4	4-1/2	5	6
Polyvinyl, Polyvinyl	2	5	8	13	19	31	44	68	92	118	148	186	268
Enamel, Synthetic Fiber Braid	2	3	5	9	12	21	30	46	62	80	100	126	182
Polyvinyl, Polyvinyl, Lead Sheath	1	1	2	4	6	11	15	24	32	42	52	66	95
Polyvinyl, Nylon	6	10	16	29	39	65	93	144	192	248	310	390	563
Teflon, Teflon	7	13	21	37	51	85	121	187	250	322	403	506	731
Mylar Tape, Synthetic Fiber Braid	1	3	4	8	11	19	27	42	56	72	90	113	163
Mylar Tape, Heat-Resistant Rubber, Synthetic Rubber	1	1	2	5	6	11	16	24	33	42	53	67	97

ISA COLOR CODE—EXTENSION WIRES

Thermocouple		Wire Insulation Color Code		
		Positive (+)	Negative (-)	Overall
Duplex Extension Wires	Nicrosil-Nisil (N)	Nicrosil: Orange	Nisil: Red	Orange
	Iron-Constantan (J)	Iron: White	Constantan: Red	Black
	Nickel, Chromium-Nickel, Aluminum (K)	Nickel, Chromium: Yellow	Nickel, Aluminum: Red	Yellow
	Copper-Constantan (T)	Copper: Blue	Constantan: Red	Blue
	Platinum, Rhodium-Platinum (R, S)	Copper: Black	#11 Alloy: Red	Green
Single Conductors	Nicrosil-Nisil (N)	Nicrosil: Orange	Nisil: Red	—
	Iron-Constantan (J)	Iron: White	Constantan: Red, White Tracer	—
	Nickel, Chromium-Nickel, Aluminum (K)	Nickel, Chromium: Yellow	Nickel, Aluminum: Red, Yellow Tracer	—
	Copper-Constantan (T)	Copper: Blue	Constantan: Red, Blue Tracer	—
	Platinum, Rhodium-Platinum (R, S)	Copper: Black	#11 Alloy, Red, Black Tracer	—

Elements

Instructions for ordering replacement elements for L&N standard thermocouple assemblies are included with the ordering information for the specific assemblies.

As a further convenience, L&N offers a variety of iron-constantan (J), nickel, chromium-nickel, aluminum (K) and platinum, rhodium-platinum (R, S) elements in standard lengths. (A number of the base-metal elements are stocked in commonly-used lengths for immediate delivery.)

CALIBRATION DATA For wire-type base-metal elements, correction data can be supplied for any specified temperature point(s) between −100 and 2300 F. Data is provided on a linen tag, wired to the element . . . can also be provided in a typed report.

For noble-metal elements, the range is between 33 and 3000 F.

For Type S elements, IPTS 68 calibration, an L&N Report of Calibration can be specified which will include EMF vs temperature in 1-degree increments over the range of 0 to 1450 C or 32 to 2600 F, correction to IPTS 68. This Report is limited to elements with a minimum length of 24",

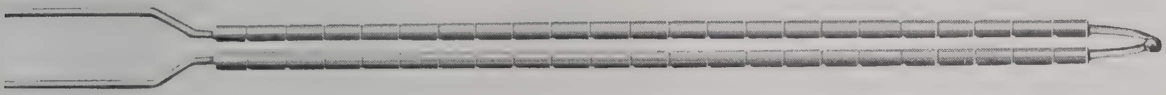


Figure A. Wires With Single-Hole Insulators

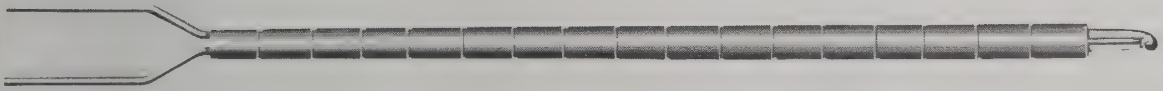
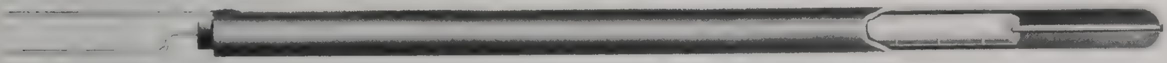


Figure B. Wires With Two-Hole Insulators

WIRE-TYPE ELEMENTS These high-quality elements for thermocouple assemblies consist of two dissimilar wires welded together at one end to form the measuring (hot) junction, and are usually insulated by single-hole or double-hole ceramic insulators. Wire-type base-metal elements with single-hole insulators are usually supplied to be used unprotected, or to mount in a protecting tube whose diameter is ¾-inch standard pipe size or larger; those with double-hole insulators, to mount in a smaller protecting tube — as small as ½-inch extra-heavy pipe size for No. 8 AWG wires, ¼-inch standard pipe size for No. 14 AWG wires. Elements with fish-spine insulators are for special applications where considerable mechanical flexibility of the thermocouple is required.

A wire-type element of a specified length has about 3 additional inches for terminal connections; e.g., element Part Number 121064, normally 24 inches long, is actually about 27 inches from junction to "cold" ends.



Iron-Constantan Pipe-Type Element

PIPE-TYPE ELEMENTS These elements consist of an 8 AWG constantan wire with single-hole insulators, enclosed in a ⅜-inch extra-heavy iron pipe and welded to the closed end. The iron pipe may be alloy-coated, if desirable. Pipe-type elements can be mounted in a protecting tube, or used bare.

Insulators			Element Part Number					
Type	Length × OD	Part No.	18"	24"	30"	36"	42"	48"
1-Hole, Round	1" × 0.34" OD	035156	—	121006**	—	—	—	—
1-Hole, Round	1" × 0.34" OD	035156	121188***	121008*	121009*	121010*	121011	121012*

*Stocked element

**Stocked element, comprises wire with insulators enclosed in uncoated iron pipe

***Comprises wire with insulators enclosed in alloy coated pipe

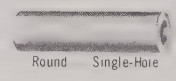
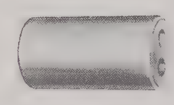
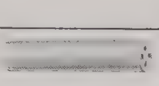
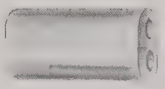
Insulators

These high-quality ceramic insulators, with single- or multiple-hole hole construction, are available in appropriate lengths and diameters for various wire sizes. Insulators with 3, 6, 8 or more holes, for use with multiple thermocouples or thermocouples for non-standard applications, are available on special order (minimum order, approximately 5000).

HOW TO ORDER Except as noted, all listed insulators are stocked for immediate delivery. The Part Number designates a single insulator or — for Fish-Spine Insulators — a packaged quantity by weight.

To order, simply specify the quantity of each Part Number.

STANDARD INSULATORS

Type	Maximum Wire Size, AWG	Upper Temperature Limit	Dimensions, Inches			Part Number
			Length	OD	ID	
 Round Single-Hole	22	2800 F	15.75 3.00	0.06 0.06	0.039 0.039	034089 034088
	18	2800 F	15.75	0.10	0.059	034090
	14	2800 F	5.00 2.00 2.00	7/32 0.16 0.10	0.090 0.080 0.078	034055 035162 034091
		2200 F	1.00	7/32	0.090	035161
	6	2200 F	1.00	0.34	0.209	035156
 Round. . .Double-Hole	24	3150 F	36.00 24.00 24.00	3/16 3/16 1/8	0.035 0.035 1/32	035281 035282 034891
	22	2800 F	6.00	0.116	0.030	034094
	20	2200 F	2.00	0.15	0.039	034092
	18	2800F	16.25 9.50	1/4 1/4	0.060 0.060	034081 034082
	16	2200 F	1.00	175	0.060	034138
	14	2800 F	3.00 1.00	7/32 0.30	0.079 0.073	034093 035144
	8	2200 F	0.50 0.50	15/32 11/16	0.166 0.196	035166 035163
 Round Four Hole	20	2800 F	1.00	3/16	0.040	034096
	16	2800 F	1.00	0.26	0.059	035137
	14	2800 F	1.00	0.30	0.073	035138
 Oval. . .Double-Hole	14	2800 F	5.00 1.00 1.00	1/4 × 9/32 1/4 × 9/32 1/4 × 3/8	0.090 0.090 0.090	035151 034065 034097
	8	2800 F	1.00	9/32 × 15/32	0.16	035154
		2200 F	1.00 1.00	15/64 × 5/8 0.350 × 0.469	0.196 0.166	035164 034968
Measuring Junction	4	2800 F	1.00	3/8 × 11/16	0.234	035149
		2800 F	0.75	25/32	0.594	035150
		2200 F	1.00 0.75 0.625	11/16 1/2 9/32	0.375 0.250 0.125	035157 035158 035159

FISH-SPINE INSULATORS*

Type	Maximum Wire Size, AWG	Dimensions, Inches			Per Lb, Approximately		Quantity	Part Number	Minimum Order
		Length	OD	ID	Quantity	Length Covered			
Single-Hole (Fish-Spine)	18	0.115	0.11	0.056	16,600	138	1/2 Lb	034365	1/2 Lb
	14	0.170	0.17	0.068	4,870	57	1/2 Lb	034364	1/2 Lb
	8	0.260 0.400	0.26 0.40	0.152 0.156	1,595 350	30 9.5	2 Lb 5 Lb 1 Lb	034501 034502 034380**	2 Lb 5 Lb 10 Lb
	6	0.400	0.40	0.180	370	10.5	1 Lb	034381**	10 Lb
	4	0.510	0.51	0.220	195	7	1 Lb	034382**	10 Lb
	3	0.540	0.54	0.240	165	6	1 Lb	034383**	10 Lb

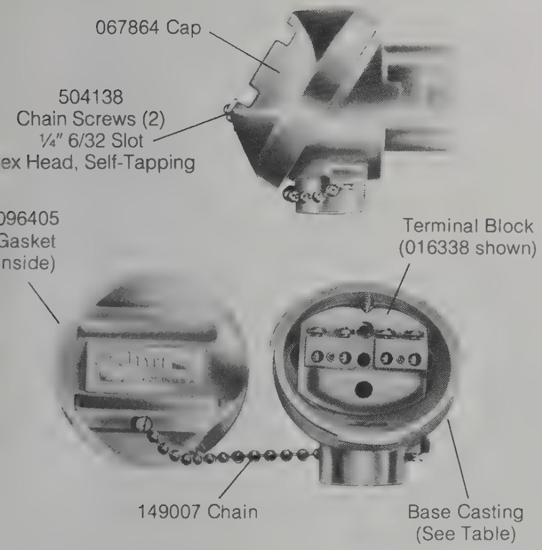
*Upper temperature limit, 2200 F **Not stocked

SPECIAL INSULATORS

Type	Maximum Wire Size, AWG	Upper Temperature Limit	Dimensions (Inches)			Unit Part Number
			Length	OD	ID	
Round. . .6-Hole	20	2200 F	1.0	0.236	0.046	034066
Round. . .4-Hole	24	2200 F	1/16	11/32	0.031	034062

Thermocouple Heads

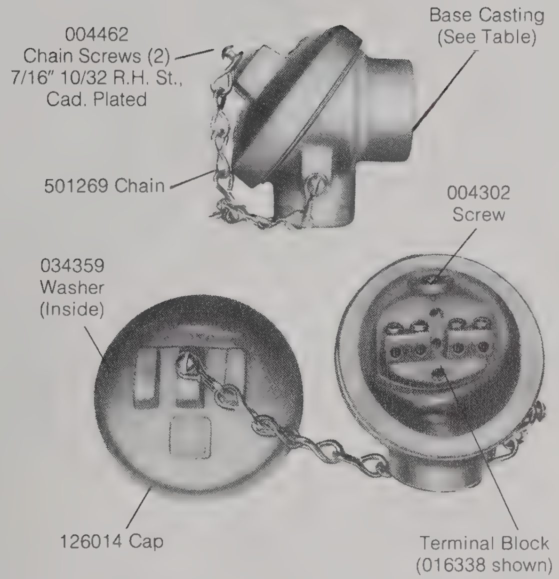
NIVERSAL HEADS



luminum Head This compact, two-piece, light-eight, weather-tight housing for terminal connections is signed to simplify the replacement of base-metal mocouple elements. The highly-polished, corrosion-esistant twist-type cap and base are joined by a beaded hain that prevents the cap from being mislaid or drop-ed when replacing elements. By the compression of a igh-temperature silicone-rubber gasket, the cap is uickly and easily secured to the body . . . a quarter turn ocks or releases it. Slots across the cap permit leverage o be applied, simplifying its removal even when hot.

The thermocouple opening is tapped for ¼", ½", ¾" or " NPT. The conduit opening is tapped for ½" NPT; an 76955 Adapter can be separately ordered to adapt it to " conduit. Where a rubber or asbestos-covered exten-on wire is used without conduit, an 034122 Molded ushing can be ordered as a separate item for the con-uit opening, to eliminate abrasion.

Note: For resale applications, the cap of the aluminum ead can be supplied with your corporate identification place of "L&N CO." (minimum order, 500). For details, onsult your local L&N Field Office.

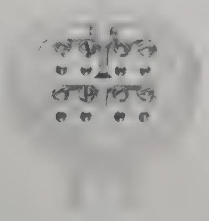


Cast-Iron Head The sturdy, two-piece malleable cast-iron head — cadmium-plated with gray painted finish — provides durable, rugged construction for heavy industrial application with base-metal or noble-metal thermocouples. A heat-and-moisture-proof gasket forms a weather-proof seal between the threaded cap-to-base connection. Slots across the cap permit leverage to be applied, simplifying its removal even when hot. A heavy-duty link-chain joins cap and base casting to prevent mislaying or dropping when replacing elements.

The thermocouple opening is tapped for ¼", ½", ¾" or 1" NPT, except for noble-metal couples (not available for ¼"). The conduit opening is tapped for ¾" NPT an 076360 Reducer can be separately ordered to adapt it to ½" conduit. Where extension wire is used without conduit, two molded bushings are available as separate items for the conduit opening: a 006153 Bushing, for extension wire with rubber or asbestos covering, or a 006152 Bushing for extension wire with lead sheath

erminal Connectors For base-metal thermocouples, e Universal Heads employ terminal connectors con-isting of brass terminal blocks non-rigidly mounted to a igh-temperature molding, with polarity markings to in-ure correct installation. The 016338 Single-Element Connector has two brass blocks, the 316236 Dual-lement Connector has four. The Connector is secured to e base casting by a single screw

or noble-metal thermocouples, the cast-iron Head mploys a 316736 Single-Element Connector or a 16745 Dual-Element Connector, designed to permit aking positive connections without damage to the ires.


316236 Dual-Element
Terminal Connector for
Base-Metal Thermocouples

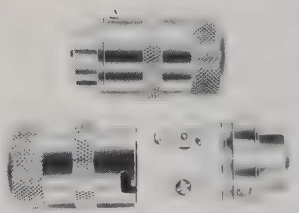
316736 Terminal
Connector for Platinum
Thermocouples

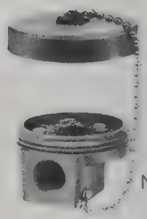
UNIVERSAL HEADS

Tapped Thermocouple Opening	Base Casting		Complete Head Assemblies				
			For Base-Metal Couples[1]				For Noble-Metal Couples[2]
			Aluminum[3]		Cast-Iron[4]		Cast-Iron[4]
	Aluminum	Cast Iron	Single-Element	Dual-Element	Single-Element	Dual-Element	Single-Element
1″ NPT	042091	126006	**042112**	**042192**	**352237**	**352241**	**042328**
¾″ NPT	042308	126009	**042309**	**042307**	**352245**	**042305**	**042330**
½″ NPT	042092	126007	**042113**	**042306**	**352240**	**042304**	**042332**
¼″ NPT	042197	126008	**042191**	**042311**	**352244**	**042310**	**NA**
$^{5}/_{16}$″ OD[5]	042092	126007	**042176**[6]	**NA**	**042063**[6]	**NA**	**NA**
$^{3}/_{16}$″ OD[5]	042092	126007	**042175**[7]	**042322**[7]	**352246**[7]	**042323**[7]	**NA**

1. *Heads for base-metal thermocouples include either an 016338 Single-Element Terminal Block or a 316236 Dual-Element Terminal Block*
2. *Heads for noble-metal thermocouples include a 316736 Single-Element Terminal Block*
3. *Aluminum heads are tapped ½″ NPT at conduit opening; to adapt to ¾″, specify an 076955 Adapter.*
4. *Cast-iron heads are tapped ¾″ NPT at conduit opening; to convert to ½″, specify an 076360 Reducer.*
5. *Heads are for use with thermocouples in tubing or sheath of the indicated OD (e.g., 8784 Assemblies). Dimension given is clearance hole*
6. *Comprises head with ½″ NPT thermocouple opening, 076906 Nut, 076907 Sleeve and 006823 Double-Ended Mounting Bushing, ½″ NPT*
7. *Comprises head with ½″ NPT thermocouple opening, 076904 Nut, 076905 Sleeve and 006822 Double-Ended Mounting Bushing, ½″ NPT*

MINIATURE HEADS



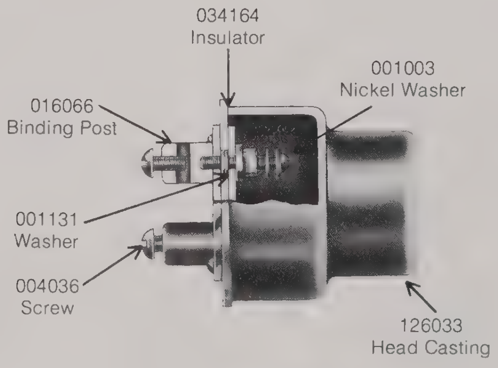


New Compact Plastic Head

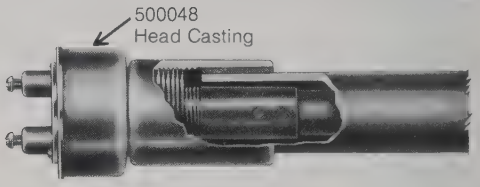
These compact, lightweight, corrosion-resistant heads can be used on 8784 Thermocouples (page B-30), or similar applications involving small tube or sheath diameters. Thermocouple opening is ¼″ NPT, for a compression fitting; leadwires — up to 14 AWG — enter through a neoprene grommet. For single-element (two-terminal) head, specify Part No. 042001; for dual-element (four-terminal) head, specify Part No. 042214.

A compact miniature plastic head measuring $2^{5}/_{32}$″ diameter by $1^{7}/_{16}$″ high and weighing 3 ounces is available for use in ambient temperatures up to 350 F. Head contains ¼″ NPT probe and extension openings. It is impervious to weather, moisture, sunlight and dust. Specify Part No. 055905.

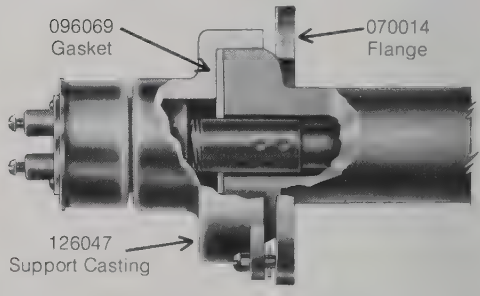
OPEN-TERMINAL HEADS



352232, 352233 or 042326 Head



042010, 042018 or 042327 Head for Mounting Secondary Tube.



352232, 352233 or 042326 Head and Parts for Mounting Silicon Carbide Secondary Tube

Designed for use with platinum thermocouples mounted in ceramic or metal-ceramic tubes, Open-Terminal Heads have external binding posts for terminal connections and carry plates identifying the thermocouple as platinum, 10% rhodium-platinum (Type S), platinum, 13% rhodium-platinum (Type R) or platinum, 30% rhodium-platinum, 6% rhodium (Type B).

The 352232, 352233 or 042326, with internal thread only, is used with a single primary tube, or — in conjunction with a support-casting, flange and gasket — with a ceramic primary tube and silicon-carbide secondary tube.

The 042010, 042018 or 042327, with both internal and external thread, is used with a ceramic primary tube and a ceramic or metal-ceramic secondary tube.

For details on standard assemblies, see 3080-Series Platinum Thermocouple Assemblies, page 35.

Thermocouple Type	Head Part Number	
	With Internal Thread for Primary Tube	With Internal Thread for Primary Tube, External Thread for Secondary Tube
Type S	**352232**	**042010**
Type R	**352233**	**042018**
Type B	**042326**	**042327**

Protection Tubes, Metal

These metal tubes are used in direct contact with high-temperature atmospheres and liquids for a variety of applications. (For recommendations, see "Selection of Protection Tubes and Wells", page 4; for thermocouple assemblies in metal tubes, see page 8.) The tubes are available in cast, drilled, welded or drawn-tubing construction, either open-end or closed-end.

Mounting An adjustable cast-iron pipe flange, with locking screw, can be provided with any metal tube, by specifying the appropriate suffix. As an alternative, a mounting bushing of cold-rolled steel, with a choice of mounting thread, can be welded on the tube.

HOW TO ORDER To order a metal protection tube, complete the catalog number (below). In sequence, the suffixes define the tube size and material **(H-Ha);** length **(Hb);** mounting fitting **(Hc);** tube length below bushing, if any **(Hd);** end construction **(He);** and tagging option **(J).**

Example: 3245-2-24-6-18-2-000 specifies a 1" std Yoloy tube **(3245-2),** 24' long **(24),** with 1½" NPT bushing welded on the tube **(6)** 18" from the hot end **(18),** closed-end construction **(2),** no tagging **(000).**

H Ha Hb Hc Hd He J

32□□-□-□□-□-□□-□-□□□

	Description			Suffix
	Material	Size*	Stocked Lengths**	
Suffix H-Ha: Protection Tube Size and Material	Cast Iron (1300 F, Max.)	⅞" ID × 1⅜" OD	12", 18", 24",	3250-1
	Yoloy, Welded (Nickel-Copper Alloy Steel; 1300 F, Max.)	½" Std	—	3241-2
		½" XH	—	3242-2
		¾" Std	—	3243-2
		¾" XH	—	3244-2
		1" Std	—	3245-2
		1" XH	18", 24", 36"	3246-2
	Seamless Steel, Drawn (Carbon Steel; 1000 F, Max.)	¼" Std	36"	3240-3
		½" Std	—	3241-3
		½" XH	—	3242-3
		¹³/₁₆" ID × 1⁵/₁₆" OD	—	3248-3
	Nickel (2000 F, Max.)	½" Std (Drawn)	—	3241-4
		1" Std (Drawn)	—	3245-4
		¹⁷/₃₂" ID × ⅞" OD (Drilled)	—	3249-1
		⅞" ID × 1⅜" OD (Drilled)	—	3250-4
	Inconel 600, Drawn (80% Nickel, 15% Chromium; 2100 F, Max.)	½" Std	12", 18", 24", 36"	3241-5
		¾" Std	12", 18", 24"	3243-5
		1" Std	12", 18", 24", 30", 36", 48", 60"	3245-5
	304 SS, Drawn (18% Chromium, 8% Nickel; 1600 F, Max.)	¼" Std	—	3240-6
		½" Std	—	3241-6
		½" XH	24", 36"	3242-6
		¾" Std	—	3243-6
		1" Std	—	3245-6
		1" XH	24"	3246-6
	316 SS, Drawn (18% Chromium, 8% Nickel, 2% Molybdenum; 1600 F, Max.)	½" Std	—	3241-7
		¾" Std	—	3243-7
		1" Std	—	3245-7
	446 SS (28% Chromium-Iron; 2000 F, Max.)	¼" Std (Drawn)	—	3240-8
		½" Std (Drawn)	18", 24", 36"	3241-8
		¾" Std (Drawn)	—	3243-8
		1" Std (Drawn)	12", 18", 24", 30", 36", 42", 48"	3245-8
		⅝" ID × 1⅛" OD (Drilled)	24"	3247-8
		⅞" ID × 1⅜" OD (Drilled)	24"	3250-8
Suffix Hb: Tube Length	Specify Protection Tube Length in *Inches* (6" Min. for All Tubes; 48" Max for 3250-1; 60" Max. for Drilled Tubes; 144" Max. for All Others)			□□
Suffix Hc: Mounting Fitting	None			0
	Adjustable Pipe Flange, 1⅛" × 3¼" OD (All Tubes)			1
	½" NPT Mounting Bushing, 1" Hex, ¾" Long (3240 Tube Only)			2
	¾" NPT Mounting Bushing, 1¼" Hex, ⅞" Long (3240 Tube Only)			3
	1" NPT Mounting Bushing, 1⅜" Hex, 1" Long (3240, 3241, 3242 or 3249 Tube Only)			4
	1¼" NPT Mounting Bushing, 1¾" Hex, 1¼" Long (All Tubes Except 3250)			5
	1½" NPT Mounting Bushing, 2⅜" Hex, 1⅜" Long (All Tubes)			6
	2" NPT Mounting Bushing, 2⅞" Hex, 1⅜" Long (All Tubes)			7
Suffix Hd: Tube Length Below Bushing	None (Specified When Suffix Hc is Either "0" or "1")			0
	Specify Tube Length Below Welded Bushing, to Hot End of Tube, in *Inches****			□□
Suffix He: Tube-End Construction	Closed-End Construction			1
	Open-End Construction			2
Suffix J: Tagging Option	None			000
	Linen Tag, Wired to Tube, With Legend as Specified.			206

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*For ID and OD of "Std" and "XH" tubes, see page 13

**Tubes of these lengths, with closed-end construction, are normally stocked.

***When a bushing is to be welded on the tube as close as possible to the head end, Suffix Hd should be specified as the Suffix Hb dimension minus 4"

Protection Tubes, Ceramic

L&N Fyrestan (high-grade mullite) and high-purity alumina are used as primary and secondary protection tubes. Alumina is impervious to gases and usable at temperatures as high as 3100 F; Fyrestan, to 2800 F. To prevent breakage due to thermal shock, both alumina and Fyrestan tubes must be preheated at the rate of 200 degrees F per hour up to 800 F.

L&N Fyrestan tubes, equipped with a metal sleeve for mounting a Universal Head, can be used whenever desirable in place of tubes of nickel and chromium alloy. Although not as strong as an alloy, Fyrestan is fully as gastight. In some applications, in the range of 1800 to 2000 F, Fyrestan outlasts alloys.

Tubes of silicon-carbide refractory are highly resistant to the destructive action of flames and gases. At temperatures as high as 3000 F, they are used as secondary protection for noble-metal thermocouples with Fyrestan primary tubes.

LT-1 metal-ceramic tubes (77% chromium, 23% aluminum oxide) are dense and corrosion-resistant, usable to about 2600 F in most atmospheres. To prevent breakage due to thermal shock, they should be preheated to a temperature of 900 F.

For detailed ceramic-tube recommendations, see "Selection of Protection Tubes and Wells", page 4.

HOW TO ORDER Most L&N ceramic tubes are stocked in lengths from 12" to 48", in 6" increments. Except for the silicon-carbide tubes with collar and the metal-ceramic tubes, intermediate lengths can be supplied on special order. Metal sleeves can be ordered separately, by those wishing to assemble their own tubes (see page 58). To order a ceramic tube, simply specify the appropriate Part Number for the desired length from the table below.

Material	ID × OD	Construction	Figure	Part Number						
				12"	18"	24"	30"	36"	42"	48"
L&N Fyrestan	¼" × ⅜"	Plain	A	065404	065221	065222	065676	065677	065678	065679*
		With 006194 Brass Sleeve	B	065671*	065618*	065619	065672*	065673*	065674*	065675*
	7/16" × 11/16"	Plain	A	065391	065392	065393	065394	065395	065553	065396
		With 065046 Brass Sleeve	C	065204	065205	065206	065207	065208	065463*	065464*
		With 276369 ¾" NPT SS Mounting Bushing	D	265821*	265822*	265823*	265824*	265825*	—	—
		With 276404 Inconel Sleeve	E	265814*	265815*	265816*	265817*	265818*	265819	265820*
	¾" × 1"	Plain	A	265719	265379*	065554	265721	265722*	—	—
		With 006179 Steel Sleeve	F	065437	065429	065430	065431	065432	—	—
	1" × 1¼"	Plain	A	065210	065211	065212	065213	065214	365072	365073
		With 006172 Steel Sleeve	G	065215*	065434	065216	065217	065218*	065219	065220
		With 006182 Steel Sleeve	H	265603*	265604*	265605*	265606*	265607*	—	—
High Purity Alumina	7/16" × 11/16	Plain	A	265801	265803	265805	265807	265809	—	—
		With 065046 Brass Sleeve	C	265800*	265802*	265804*	265806*	265808*	—	—
		With 276369 ¾" NPT SS Mounting Bushing	D	265845*	265846*	265847*	265848*	265849*	—	—
		With 276404 Inconel Sleeve	E	265840*	265841*	265842*	265843*	265844*	-	—
	1" × 1¼"	Plain	A	265827	265829	265831	265833	265835	—	—
		With 006182 Steel Sleeve	H	265826*	265828*	265830*	265832*	265834*	—	—
Ceramic-Bonded Silicon Carbide	1" × 1¾"	Plain	A	—	—	065243	265617*	065244*	—	—
		With Collar, 3" OD × 1"	I	065245	065246	065247	065248	065249	065250	065251
LT-1 Metal-Ceramic (77% Cr, 23% AlO)	⅝" × ⅞"	Standard ¾' Conduit Thread	J	265659	265660	265661	265662	265663	—	—

*Non-stocked

CERAMIC TUBES

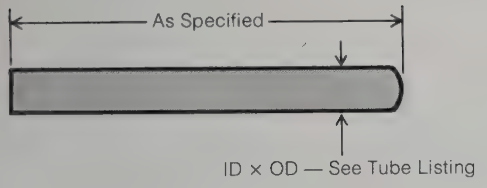

As Specified
ID × OD — See Tube Listing

Figure A — CERAMIC TUBE — PLAIN

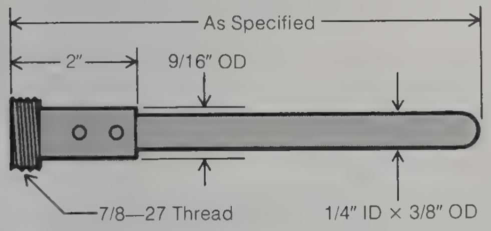

As Specified
2"
9/16" OD
7/8—27 Thread
1/4" ID × 3/8" OD

Figure B — CERAMIC TUBE WITH 006194 BRASS SLEEVE

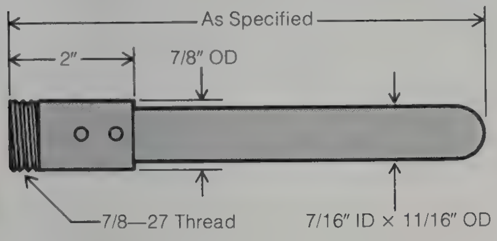

As Specified
2"
7/8" OD
7/8—27 Thread
7/16" ID × 11/16" OD

Figure C — CERAMIC TUBE WITH 065046 BRASS SLEEVE

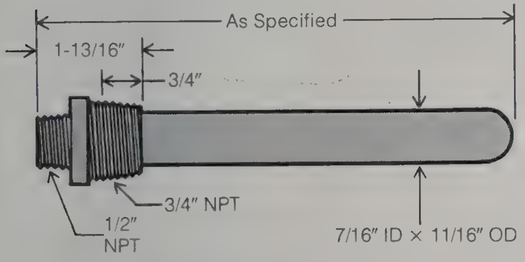

As Specified
1-13/16"
3/4"
3/4" NPT
1/2" NPT
7/16" ID × 11/16" OD

Figure D — CERAMIC TUBE WITH 276369 STAINLESS STEEL MOUNTING BUSHING

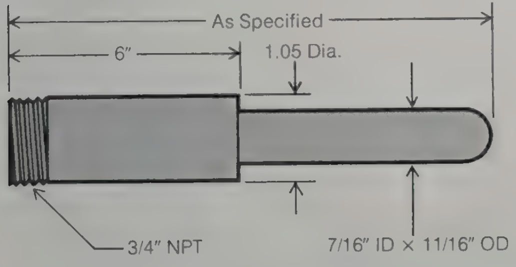

As Specified
6"
1.05 Dia.
3/4" NPT
7/16" ID × 11/16" OD

Figure E — CERAMIC TUBE WITH 276404 INCONEL SLEEVE

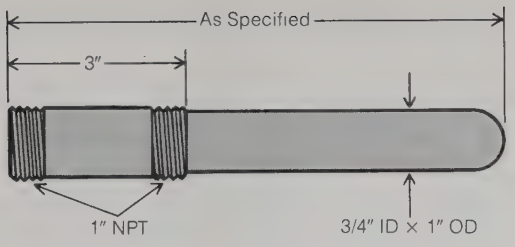

As Specified
3"
1" NPT
3/4" ID × 1" OD

Figure F — CERAMIC TUBE WITH 006179 STEEL SLEEVE

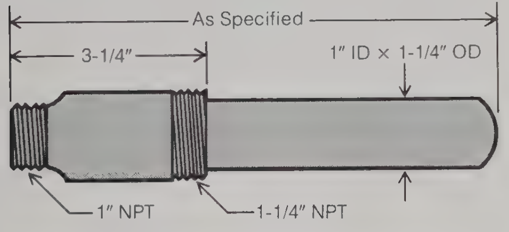

As Specified
3-1/4"
1" ID × 1-1/4" OD
1" NPT
1-1/4" NPT

Figure G — CERAMIC TUBE WITH 006172 STEEL SLEEVE

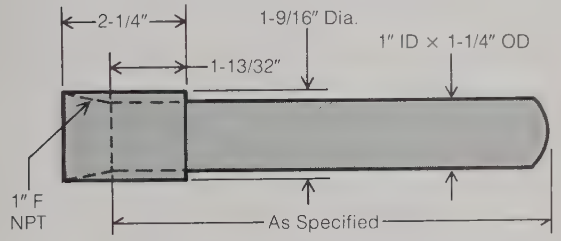

2-1/4"
1-9/16" Dia.
1" ID × 1-1/4" OD
1-13/32"
1" F NPT
As Specified

Figure H — CERAMIC TUBE WITH 006182 STEEL SLEEVE

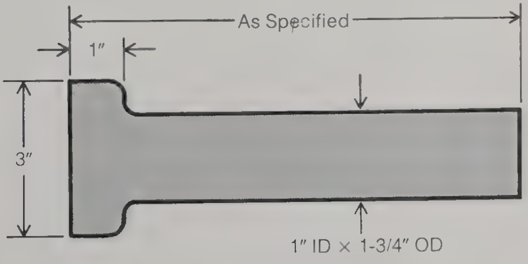

As Specified
1"
3"
1" ID × 1-3/4" OD

Figure I — CERAMIC BONDED SILICON CARBIDE TUBE

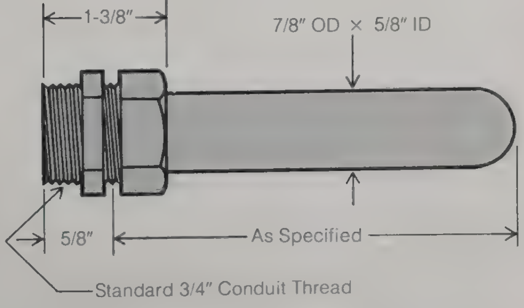

1-3/8"
7/8" OD × 5/8" ID
5/8"
As Specified
Standard 3/4" Conduit Thread

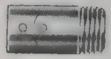
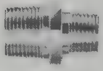
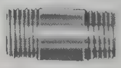
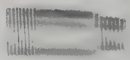
Figure J — METAL (77% CHROMIUM) CERAMIC (23% ALUMINUM OXIDE) TUBE

Sleeves, Flanges & Mounting Bushings

SLEEVES FOR CERAMIC TUBES

Metal sleeves for mounting Open-Terminal or Universal Heads are cemented on ceramic tubes (see page 56), or are available as separate items. Sleeves for the Universal Heads have both ends threaded, one for the head, the other for mounting the assembly in installations where a ceramic tube is used in place of a metal tube with a bushing

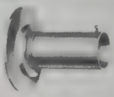
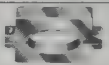
Cement for assembling the metal sleeves to ceramic tubes can also be supplied. Specify Part Number 083005 Cement (½ pint).

Head	Tube OD	Sleeve			Illustration
		Length x OD x ID	Description	Part Number	
Open-Terminal Head	⅜"	2" × 9/16" × 0.4375"	Brass sleeve; one end threaded, ⅞" × 27	006194	
	11/16"	2" × ⅞" × 0.757"		065046	
Universal Head	11/16"	1 13/16" × 1.05" × 0.781"	316 stainless-steel mounting bushing; ½" NPT for head, ¾" NPT for mounting	276369	
		6" × 1.05" × 0.824"	Inconel sleeve; ¾" NPT for head	276404	
	1"	3" × 1.315" × 1 1/16"	Carbon-steel sleeve; 1" NPT for head and mounting	006179	
	1¼"	3¼" × 1.66" × 1.38"	Carbon-steel sleeve; 1" NPT for head, 1¼" NPT for mounting	006172	
		2¼" × 1 9/16" × 1.38"	Aluminum sleeve; 1" NPT female thread at head end	006182	

ADJUSTABLE FLANGES

Adjustable flanges can be specified with most metal and ceramic tube assemblies by using the appropriate suffix to the catalog number.

Flanges may also be ordered as separate items; part numbers and descriptions are given in the table below.

Application	Mounting	Material and Construction	Tube Size	Part Number	Illustration
For Metal Tubes	Clamps to Tube	Cast-Iron Flange, with locking screw; Flange OD, 3¼"	¼ IPS ½ IPS ¾" IPS 1 IPS	070006 070007 070001 070002	
For Ceramic Tubes	Clamps to Sleeve	Malleable Iron Flange, 4" OD, threaded on 1¼" std wrought iron pipe 5½" long, with locking screw	1.315" OD Sleeve	070005	
		Malleable Iron Flange, 4½" OD, threaded on 1½" std wrought iron pipe 5 3/16" long, with locking screw	1.66" OD Sleeve	070004	
	Clamps to Tube	Brass Casting, two-piece spring-type. Supplied with two locking screws and nuts, and asbestos lining. Length, ½"; 2⅜ square	1¾ OD	070009	

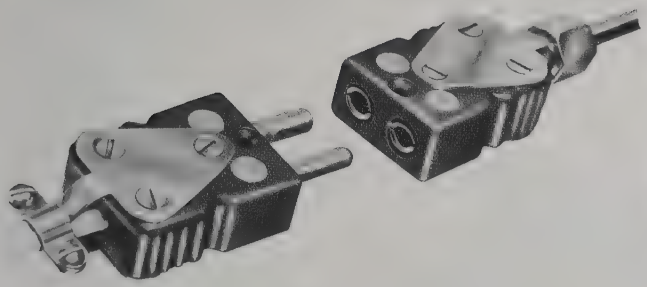
MOUNTING BUSHINGS FOR METAL TUBES

Mounting bushings (cold-rolled steel) can be specified to be welded on a metal tube, either supplied separately or as part of a 3070- or 3071-Series Assembly. Size (mounting thread) and location in the tube are specified by appropriate suffixes. (Bushings of special alloys can also be supplied.)

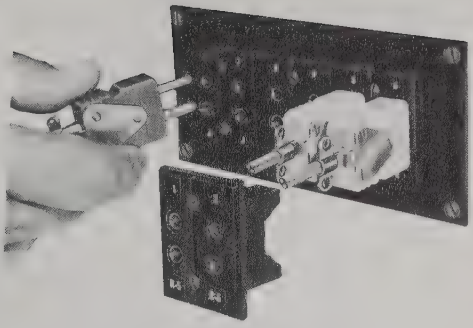
To order a cold-rolled steel bushing as a separate item, simply specify the appropriate Part Number from the Table

Pipe Thread on Bushing (NPT)	Used on Pipe Size	Bushing Part Number	Pipe Thread on Bushing (NPT)	Used on Pipe Size	Bushing Part Number
½	¼ std	006203	1½	¼ std ½ std ¾ std 1 std	006165 006164 006572 006403
¾	¼ std	006205			
1	¼ std ½ std	006207 006160			
1¼	¼ std ½ std ¾ std 1 std	006162 006161 006163 006138	2	½ std 1 std 1¾ OD	276123 276125 306074

Quick Disconnects



Quick Disconnects with Cable Clamp (left), Tube Adapter (above)



Front, 2-Circuit Panel; Back, 6-Circuit Panel in Mounting Plate

L&N QUICK DISCONNECTS provide positive identification (ISA color-coded), long-life reliability and installation simplicity. They provide a rapid and reliable method of interchanging thermocouples in temperature-measuring applications that require frequent checking in many locations, at ambient temperature up to 450 F. (On special order, connectors for use up to 800 F can be supplied.) They connect to either compacted-ceramic thermocouples or thermocouple extension wires (up to 14 AWG), and are available in both male and female types for most of the standard calibrations. To order Quick Disconnects or accessories, simply specify the appropriate Part Number.

For Thermocouple Type	Color Code	Calibration Marking	Part Number	
			Female	Male
Iron-Constantan	Black	J	**040417**	**040432**
Copper-Constantan	Blue	T	**040418**	**040433**
Nickel, Chromium-Nickel, Aluminum	Yellow	K	**040419**	**040434**
Plat. 10% & 13% Rhod.-Plat.	Green	RS	**040420**	**040435**
Nickel, Chromium-Constantan	Violet	E	**040421**	**040436**
Copper-Copper	White	CU CU	**040457**	**040458**
Nicrosil-Nisil	Orange	N	062265	062266

CABLE CLAMPS Cable Clamps (see photo) can be provided for either male or female connectors for wire sizes to ⅜"; specify Part Number 072513.

TUBE ADAPTERS Tube Adapters (see photo) to mount the male or female Quick Disconnect rigidly on a compacted-ceramic thermocouple can be supplied in various sizes.

SIZE (Tube OD)	$\frac{1}{16}$"	⅛"	$\frac{3}{16}$"	¼"	$\frac{5}{16}$"
Part Number	076792	076793	076794	076795	076796

2-CIRCUIT PANELS Providing the flexibility required for multi-circuit temperature applications, this miniature 2-circuit unit — designed for panel mounting — consists of 2 female collet-type, spring-loaded connectors that will accept 2 male connectors and accommodate wire sizes as large as 14 AWG. Numbered circuits assure proper identification from either side of the panel. The units can be mounted singly or in any combination.

Cutout dimensions for panel mounting are: 1¼" (h) × $1\frac{5}{16}$" (w) for 2-circuit, $2\frac{13}{16}$" (w) for 4-circuit, $4\frac{5}{16}$" (w) for 6-circuit, $5\frac{13}{16}$" (w) for 8-circuit and $8\frac{13}{16}$" (w) for 12-circuit combinations.

5-CIRCUIT PANELS These units provide five female collet-type, spring-loaded connectors on one compact panel, 4½" (h) × 2¾" (w), accommodating wiring as large as 14 AWG. They can be flush-mounted on any control panel or an L&N conduit box (Part Number 239267) for connecting up to 5 sets of leads to your temperature measuring or controlling equipment. The panel can be mounted singly or in groups of two or more Positive identification is assured by color-coded disks and circuit symbols (on panel front) plus numerically marked circuits and polarity (on rear of panel).

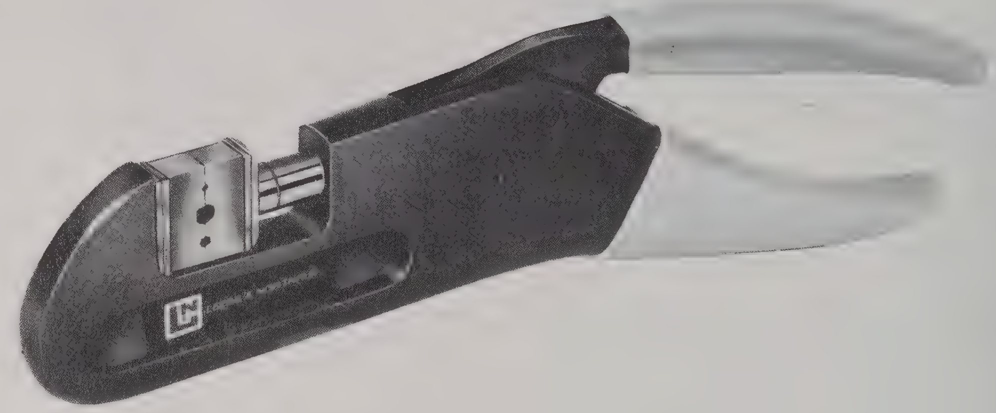
Thermocouple Type	2-Circuit Panels	5-Circuit Panels		
	Part Number	Disk Markings	Disk Color	Part Number
Iron-Constantan	**040427**	J	Black	**040422**
Copper-Constantan	**040428**	T	Blue	**040423**
Nickel, Chromium-Nickel, Aluminum	**040429**	K	Yellow	**040424**
Plat., 10% & 13% Rhod.-Plat.	**040430**	R-S	Green	**040425**
Nickel, Chromium-Constantan	**040431**	E	Violet	—

MOUNTING PLATES AND LABELS For a customized appearance, L&N can supply Mounting Plates to accommodate 1, 2, 3, 4 or 6 two-circuit panels

Panels	Circuits	Plate Dimensions (h × w)	Part Number
1	2	2⅝" × 2¾"	**269218**
2	4	2⅝" × 4¼"	**269219**
3	6	2⅝" × 5¾"	**269220**
4	8	2⅝" × 7¼"	**269221**
6	12	2⅝" × 10¼"	**269222**

Two sets of Identification Labels numbered 1 through 24 — applicable to either 2-circuit or 5-circuit Panels — are available if you prefer to identify your own circuits. To order, specify Part Number 187592

Quiktip® Tool and Connectors for fabricating thermocouple junctions



The use of the 064146 Quiktip Tool with special alloy connectors, provides a simple, economical and convenient method of fabricating "hot" junctions of basemetal thermocouples made from solid wires from 14 to 30 AWG. The simplicity of this proven technique, eliminating the need for welding, and the cold-working and thermal stress normally associated with forming junctions, permits even an inexperienced operator to produce consistently uniform results in seconds, in plant or laboratory. (Destructive life tests, extensively conducted by L&N, have shown that the junction outlasts the thermocouple wire.)

The key to this simple economical technique is the unique combination of the Quiktip Tool and Connectors. The connector is special metal collar which slides over the clean, bare wires. The precision Tool—portable, lightweight, hand-operated—is used to squeeze or crimp the connector and wires together in a pressure fit. A ratchet arrangement prevents releasing the jaws until the Tool has been completely closed, assuring a solid junction.

The Quiktip Connector is compatible with all basemetal thermocouples—Types J, K, T, N (Nicrosil-Nisil) and E—for temperatures from –200 to 1800 F. (Normal temperature limitations for the specific thermocouple still apply; see back of sheet.) Wires must be clean and bright; oxidized wires should not be used unless the oxide is removed from the junction region.

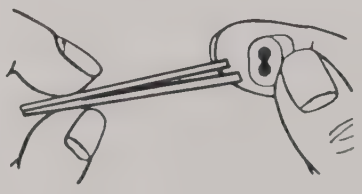
Equipment

064146 Quiktip Tool For solid wires from 14 to 30 AWG. Three jaw openings provided: for 14, 16 and 18 AWG; for 20 and 22 AWG; and for 24 to 30 AWG. Weight, 2 lb; supplied in plastic carrying case.

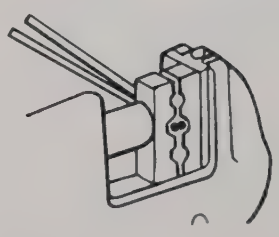
Quiktip Connectors Packaged in quantities of 100. Specify Part Number:

128540	100 Connectors for 24 to 30 AWG Wires
128543	100 Connectors for 20 and 22 AWG Wires
128542	100 Connectors for 14, 16 and 18 AWG Wires

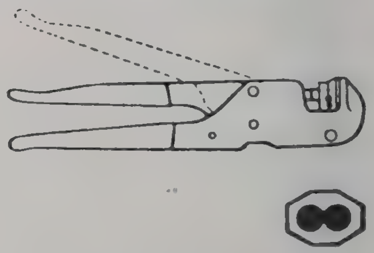
Inexpensive method for fabricating thermocouple junctions in three steps . . .



1. Insert the wires into the Quiktip Connector.

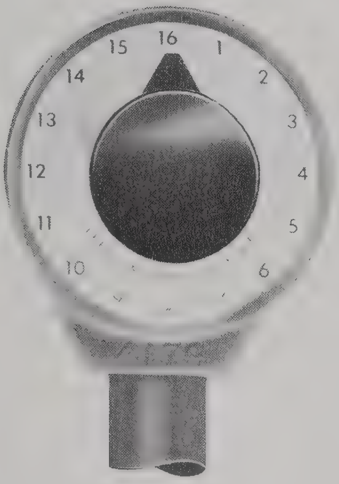


2. Properly seat wires and Connector in the appropriate jaw opening.



3. Close the jaws to form the junction

Switches, Terminal Boxes



8248 Switch
Assembly

SWITCH ASSEMBLIES

These double-pole, rotary-type assemblies are used to connect a number of individual thermocouples successively to the same indicator where indicator readings only are desired. They utilize the high-quality Type 31 switch with silver-alloy contacts, to provide low thermals of less than 1 microvolt and contact resistance of less than 0.001 ohm, with variations of less than 0.0005 ohm. The switch is housed in a rugged aluminum casting, and features an alumilited aluminum dial and pointer, with bold numbers for maximum readability. Three-foot leads of color-coded vinyl-insulated copper wire are soldered to the switch-terminals. A suitable number of terminal blocks are supplied. Assemblies can be flush-, surface-, or conduit-mounted. The switch can be rotated in its housing to positions 90° apart so that conduit can extend from top, bottom or either side.

HOW TO ORDER For a 10-point switch (1 to 10 plus "0" transfer position), specify Catalog Number 8248-10; 12-point, 8248-12; 16-point, 8248-16.

TERMINAL BOXES

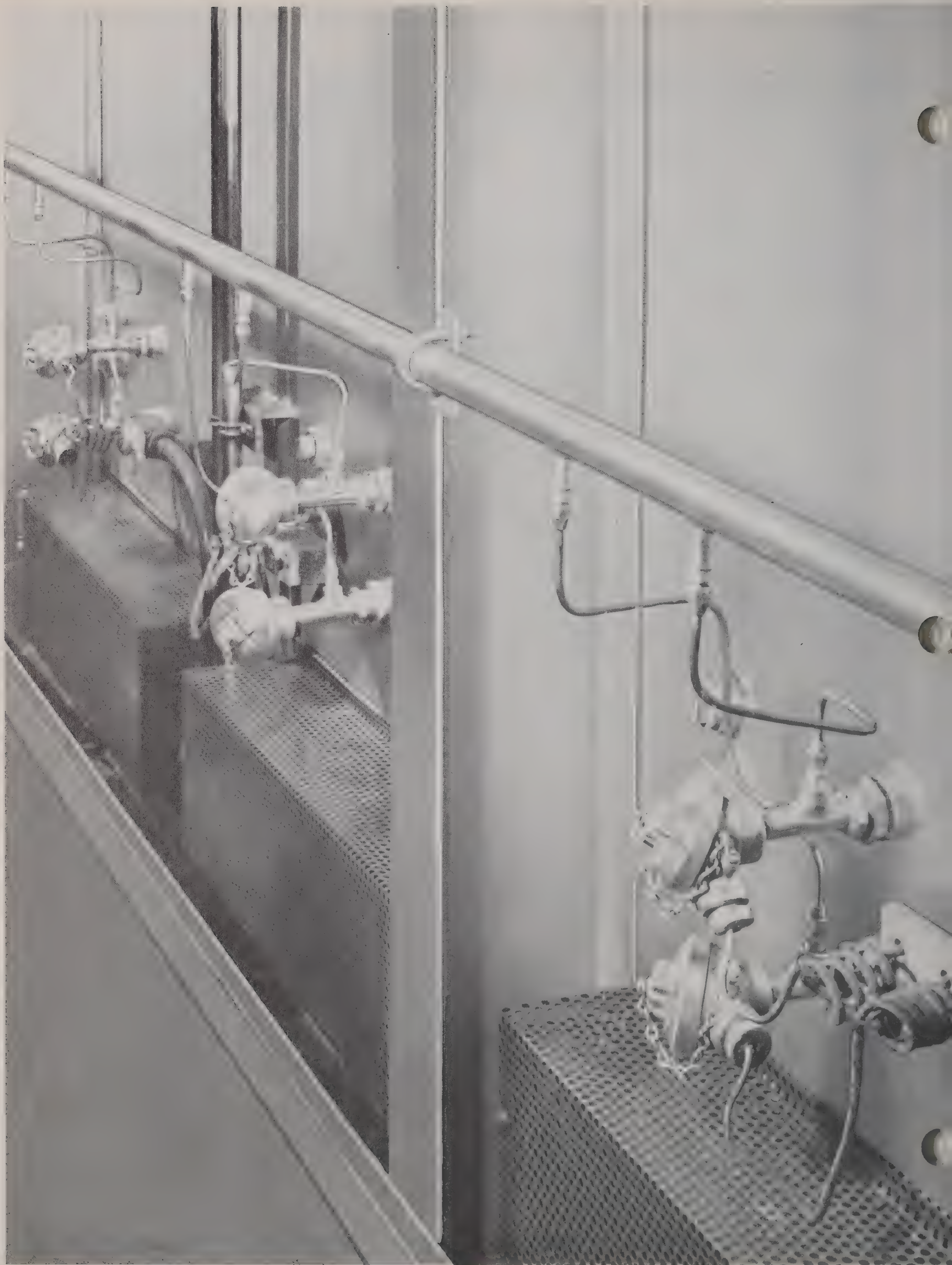
A number of thermocouples connected to the same instrument usually have their reference junction located at the instrument by means of extension wires. When instrument and thermocouples are widely separated, it is often advantageous to avoid long extension wires and resulting high resistance by locating the reference junction in an external terminal box. With this arrangement, all wiring between the box and the instrument is copper with the exception of a pair of extension wires, and it is necessary to use extension wires only between the thermocouples and the box.

Non-weatherproof sheet-metal terminal boxes have from 6 to 15 sets of concentric conduit knockouts, on top, bottom and sides. Weatherproof boxes have from 2 to 8 threaded hubs welded to the bottom of the box to accommodate conduits.

Selection of a terminal box with an adequate number of terminals is determined by adding (1) twice the number of individual thermocouples, plus (2) twice the number of recorder points with parallel thermocouples, plus (3) one terminal for remote reference junction, if required.

Number of Terminals	Dimensions (h x w x d)	Catalog Number	
		Non-Weatherproof	Weatherproof
36	20" × 10" × 6"	10054-P-36	10054-PW-36
84	20 × 16 × 6	10054-P-84	10054-PW-84
128	24 × 18 × 6	10054-P-128	10054-PW-128
160	24 × 24 × 6	10054-P-160	10054-PW-160

10054 Terminal Box



Thermal Radiation Detectors

Radiation sensors are used for non-contact temperature measurements of hot surfaces. The radiation from a hot surface is focused on a heat-sensitive element that develops a millivolt signal related to the temperature of the surface. This signal is transmitted to a suitable measuring instrument for indicating, recording or controlling.

Rayotube® detectors utilize a single- or double-mirror optical system to focus heat, radiated from the source whose temperature is being measured, upon a blackened disc. Attached to the disc are the measuring junctions of a thermopile. Temperature of the disc rises until the rate of heat loss from the disc equals the rate of energy absorption from the source. Since the reference junctions of the thermopile are at the temperature of the housing, the difference in temperature between the "hot" and "cold" junctions produces a millivoltage output which, at the measuring instrument, is indicated in terms of the temperature of the source.

Spectray® detectors respond to a narrow spectral band, eliminating common inaccuracies attributed to the presence of carbon dioxide and water vapor in the atmosphere between detector and target. Utilizing a single-mirror optical system to focus selected radiation from the heated surface upon a photovoltaic cell, the sensors provide a millivoltage which is a function of the surface temperature.

The 8888 Linearizer-Plus converts the non-linear millivolt output from a Rayotube or Spectray detector to a linear analog or digital signal. The Linearizer can be a self-contained indicator with LED digital display, or can function as a transmitter supplying a linear output to a recorder or controller equipped with a linear scale, for improved resolution over the entire temperature range.

18890-Series Thin-Film Rayotube® Detectors

for non-contact continuous temperature measurement and control

- Non-contact continuous temperature measurement of hot surfaces, from 200 to 5000 F
- Direct-sighting for surface measurements of stationary or moving targets; or
- Sighting into closed-end target tube for measurement of furnace atmosphere or other media
- Excellent reproducibility of measurement — ideal for control applications
- Thin-film thermopile for fast response; time constant of 0.015 second
- Small target-area requirement — permits using small-diameter sighting or target tube
- Rugged construction for severe industrial environments
- Usable at 32 to 212 F ambient without forced cooling
- Standard mountings permit optional forced-air or water cooling at high ambients, air purging of tubes
- Easy to install, easy to service; only occasional cleaning required
- Low initial cost
- Ordering of complete assemblies simplified by catalog numbering

For continuous temperature measurement in many industrial applications — and quite frequently, in applications where other methods prove impractical — the L&N Rayotube temperature detector provides a sensitive, stable, and highly responsive sensing element.

Since this detector responds to *radiated* heat energy, it can measure the temperature of either stationary or moving surfaces . . . or, sighting into a closed-end "target tube," it can measure the temperature of a furnace atmosphere or other medium

Rayotube temperature detectors can be used with a variety of L&N instruments for measurement and control, including Speedomax indicators, recorders and controllers and the 8888 Linearizer

Rayotube Operation — Utilizing a single-mirror optical system, the 18890-Series Rayotube detector focuses heat, radiated from the source whose temperature is being measured, upon a blackened disk. Attached to the disk are the measuring junctions of a thin-film thermopile. Temperature of the disk rises until the rate of heat loss from the disk equals the rate of energy absorption from the source. Since the reference junctions of the thermopile are at the temperature of the housing, the difference in temperature between the "hot" and "cold" junctions produces a millivoltage output which, at the measuring instrument, is indicated in terms of the temperature of the source.

Calibration — The millivolt-temperature calibration curve of the Rayotube is non-linear, and — unless a linearizing device is used — provides greater temperature sensitivity (i.e., more millivoltage output per degree change) at the high end of a selected range than at the low end. This is largely because the radiation intensity is approximately proportional to the fourth power of the absolute temperature of the source. Calibration curves for the 18890-Series, in tabular form for all standard ranges, are included in Direction Book 277122.

Ambient Temperature Compensation — To maintain reproducibility of measurement, the millivoltage signal from the detector for a given source temperature must be constant over a wide range of ambient temperatures.

If no compensation were provided, the millivoltage output would decrease slightly with increasing ambient temperature. An integral sensistor is employed to maintain a constant signal output despite varying housing temperatures, over a range of 32 to 212 F. (An air- or water-cooled mounting jacket can be provided for the detector where ambient temperatures exceed 212 F.)

Since no external reference-junction compensation is required, no special extension leadwires are necessary to connect the Rayotube detector to the measuring instrument. Suitably insulated copper wires are adequate.

Emittance Compensation — Each Rayotube has engraved on its nameplate the value of emf which it produces when sighted on a source under blackbody conditions at the highest temperature of its range, as compared to an N.B.S.-calibrated standard.

In practice, these "ideal" conditions are usually attained only when the Rayotube detector sights into a closed-end target tube. In nearly all direct-sighting applications, the emittance of the target is *less* than 1 — varying with the material and surface condition of the target — and the millivoltage value is proportionately less. In order that the true temperature of the source may be indicated throughout the temperature range, an emittance compensator dial on a Speedomax recorder or controller or 8888 Linearizer, for example, permits adjusting the electrical span of its measuring circuit to match the output of the Rayotube detector.

In target-tube applications, the calibrated compensator is merely set to the millivoltage value corresponding to the Rayotube output at the high end of its range (inscribed on the Rayotube nameplate).

In direct-sighting applications, the compensator is initially adjusted until the instrument reading matches that of the checking device . . . a checking thermocouple, or an L&N Optical Pyrometer. In applications where two or more direct-sighting Rayotube detectors are connected to a Speedomax recorder or other multi-point readout device using a common compensator, the millivolt adjustment screw on each Rayotube can be provided unsealed; this permits field-matching millivolt outputs at the same temperature.

Speed of Response — Rayotube response is expressed as the *time constant:* the time required for a Rayotube to attain 63.2% of the difference between initial and final millivoltage output, when suddenly exposed to a source of higher temperature.

For the 18890-Series, the time constant is only 0.015 second, making it highly responsive to temperature change, and well-suited to direct-sighting applications where source temperature varies rapidly, or where temperature variations along a moving body — e.g., steel sheet or strip — must be measured.

Target Area — Size of target required for optimum Rayotube performance varies directly as the distance between the detector and the target. For the 18890-Series Rayotube detectors,

$$T = 0.018(D + 2.5''),$$

where T is the minimum target diameter required and D is the distance from the detector window to the target in inches. The small target-diameter requirement of the 18890-Series permits the use of small-diameter sighting or target tubes, with a saving in cost.

Focus — All 18890-Series Rayotube detectors are prefocused to one of six focal lengths, as specified in the catalog number. When ordering a direct-sighting assembly, focus is determined by the distance "D", from the Rayotube window to the target. When ordering a target-tube assembly, focus is determined by the tube length plus a length "M" (see diagram) which varies with the mounting assembly.

Values of "M" are:
For Suffix CD = 310 or 320 : 2.25″
For Suffix CD = 311, 312, 321, 322 or 330 : 4.0″
For Suffix CD = 331 or 332 : 6.2″

Temperature Range — When a Rayotube detector is used with a Speedomax instrument with a non-linear scale and chart, a range should be selected (see "Range Table") so that the temperatures normally measured or controlled fall in the upper one-third of the span (which covers approximately one-half of the scale and chart) for best resolution.

When a Rayotube detector is used with a device to linearize the output, such as the 8888 Linearizer, resolution will be uniform across the span, and any appropriate range may be selected.

SPECIFICATIONS

Type: Radiation-type temperature detector, comprising single-mirror optical system with image-viewing lens.

Element: Thin-film thermopile.

Resistance: Approximately 1500 ohms.

Time Constant: 0.015 second, for 63.2% of an instantaneous temperature change.

Range: 200 to 5000 F. For standard temperature spans, see "Range Table."

Optional Output Adjustment: To permit matching millivolt outputs of two or more detectors in direct-sighting applications when used with multipoint recorders, the external millivolt adjustment screw can be left unsealed.

Housing: Brass-alloy forging, nickel-plated and hermetically sealed, with three slotted holes for mounting.

Electrical Connections: Two screw terminals on terminal block, accessible beneath cover, for copper leadwire connections to measuring instrument.

Dimensions: $3^{5}/_{16}''$ OD by $3^{5}/_{8}''$ long (84 × 93 mm)

OPERATING LIMITS

Ambient Temperature: 32 to 212 F (0 to 100 C), without forced-air or water cooling.

Pressure: 40 psig (275 kPa).

Vibration: 1 g at 10 to 200 Hz.

Relative Humidity: To 90% R.H. at 104 F (40 C).

PERFORMANCE CHARACTERISTICS

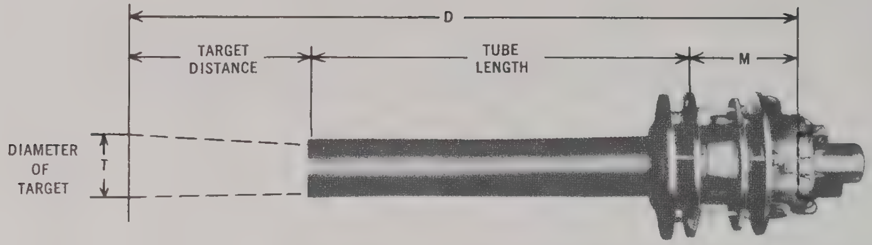
Spectral Response: On ranges 0163 (200-1000 F) and 1019 (650-1400 F): 0.3 to 10.5 microns. On all other ranges: 0.3 to 4.5 microns.

Output at High End of Range: 24 mV, for ranges to 2300 F (1260 C) or higher. For lower ranges, high-end output varies with range (see "Range Table").

Stability: Within 1% of reading over 6000 hours at 130 F (55 C) ambient temperature

Calibration: Each unit is calibrated at blackbody conditions; the tolerance and conformity to the temperature curve is 1% of reading over the entire range.

Temperature Coefficient: Output at a given temperature will not change by more than 1% for a 100 F° (38 C°) ambient temperature change.



RAYOTUBE® ASSEMBLIES

For most applications, the complete Rayotube assembly comprises a Rayotube detector, a mounting assembly, mounting safety features (if required) and a sighting or target tube.

Mounting Assembly — The Mounting Assembly joins the Rayotube detector to the sighting or target tube and consists of a Cooling Jacket, one or two mounting flanges, and other accessory items as specified. (See assembly schematics for details.)

Air/Water Cooling Jacket: For use at ambient temperatures from 32 to 212 F (0 to 100 C), this unit also has an inlet and outlet for forced-air or circulating water, to cool it where ambients are above 212 F. Three quick-release latches lock the Rayotube detector to the Jacket; the detector can be removed for window-cleaning, service or replacement without disturbing the Mounting.

Air/Water Cooling Jacket with Air Purge (Nozzle): Includes a nozzle for connection of purging air to clear a sighting tube where smoke, fumes, dust, etc. are extremely heavy; is occasionally used to prevent seepage of fumes into a target tube. Assembly permits combining water-cooling of the Jacket with air purging of the tube, or air-cooling of the Jacket with outlet air from the Jacket connected to the nozzle for purging. Quick-release latches are provided.

Air Cooling Jacket with Integral Air Purge: Used to purge a sighting tube where conditions are not severe. Jacket has holes drilled in base and cooling-air outlet plugged so cooling air exhausts down tube. Quick-release latches are provided.

Mounting Safety Features: Where hot gas or flame might reach the window and damage the detector, either through an open-end sighting tube or a broken ceramic target tube, a Safety Shutter — actuated by a bimetallic trip at 212 F (100 C) — can provide temporary protection.

Since the action of the Safety Shutter cuts off the detector signal output, a Safety Switch, tripped by the Shutter, must be specified in control applications to open the control circuit.

Tubes: Available standard tubes are described in a table on this sheet. Temperature limits and operating conditions will dictate a choice of material. An open-end tube should be long enough to provide a clear sighting path (with air purging, if required); a closed-end tube should extend far enough into the furnace atmosphere (or other medium) to provide a representative temperature source. See page 69 for mounting hardware.

Tubes

Material	Construction	Recommended Maximum Temperature	Description
Inconel	Open- or closed-end	2100 F	80% nickel, 15% chromium alloy. High mechanical strength, rugged; should be used in place of ceramic tube (conditions permitting) where work in furnace is withdrawn frequently or may strike tube. Should not be used in sulfur atmospheres or where producer gas is used as fuel.
Fyrestan	Open- or closed-end	2800 F. When mounted horizontally, 2500 and 2300 F, respectively, for unsupported lengths of 12 and 18 inches.	Refractory of mullite and glass, with high impermeability.
Fyrestan-Lined Silicon Carbide	Closed-end only	2800 F	Silicon-carbide tubes are somewhat porous at high temperature; this tube combines the mechanical strength of silicon carbide with the high impermeability of Fyrestan.
Silicon Carbide	Open- or closed-end	3000 F	Features high thermal conductivity, thermal-shock resistance, abrasion resistance and strength, and relatively high impermeability.
Refrax	Closed-end only	3100 F	Silicon-nitride-bonded silicon carbide. Excellent thermal-shock resistance, abrasion resistance, strength; higher impermeability than silicon carbide.
Hi-Purity Alumina	Open- or closed-end	3400 F, mounted vertically; mounted horizontally, must be supported at temperatures above 3000 F (even in 12" lengths)	High-temperature refractory, but with low thermal-shock resistance

HOW TO ORDER

Specify appropriate suffixes to complete the catalog number.

A B C D E F
18890-☐☐☐☐-☐☐☐-☐☐☐-☐☐☐-☐☐☐-
G H
☐☐☐-☐☐☐

Suffix A. Range	
Specify Range Suffix from the Table	☐☐☐☐
Suffix B. Focus	
4 Inches	**104**
6 Inches	**106**
7 to 12 Inches	**109**
12 to 16 Inches	**113**
16 to 24 Inches	**118**
24 Inches to Infinity	**124**
Suffix C. Mounting	
Air/Water Cooling Jacket	**31**
Air/Water Cooling Jacket with Air Purge (Nozzle)	**33**
Air Cooling Jacket with Integral Air Purge	**32**
Suffix D. Mounting Safety Features	
None	**0**
Safety Shutter*	**1**
Safety Shutter and Safety Switch*	**2**
Suffix E. Tube Type and Material	
Sighting Tube	
Fyrestan (1.44″ ID, 1.63″ OD)	**411**
Silicon Carbide (1.31″ ID, 2.11″ OD)	**421**
Hi-Purity Alumina (1.44″ ID, 1.63″ OD)	**431**
Inconel 600 (1.39″ ID, 1.67″ OD)	**441**
Target Tube	
Fyrestan (1.44″ ID, 1.63″ OD)	**412**
Silicon Carbide (1.31″ ID, 2.11″ OD)	**422**
Hi-Purity Alumina (1.44″ ID, 1.63″ OD)	**432**
Inconel 600 (1.39″ ID, 1.67″ OD)	**442**
Refrax (2.12″ ID, 3.16″ OD)	**452**
Silicon Carbide with Fyrestan Liner (1.65″ ID, 3.16″ OD)	**462**
Suffix F. Tube Length	
12 Inches**	**512**
18 Inches***	**518**
24 Inches	**524**
30 Inches	**530**
Suffix G. Options	
(Omit Suffix if Not Required)	
Unsealed Millivolt Adjustment Screw	**601**
Suffix H. Tagging	
(Omit Suffix if Not Required)	
1 Linen Tag (Specify Legend)	**206**
1 Aluminum Tag, Machine-Stamped, 15 Characters Max. (Specify Legend)	**207**
1 Stainless Steel Tag, Electro-Etched, 22 Characters Max. (Specify Legend)	**208**

**Not for use with metal tubes*
***Not available for Refrax or Silicon Carbide with Fyrestan liner*
****Not available for Refrax.*

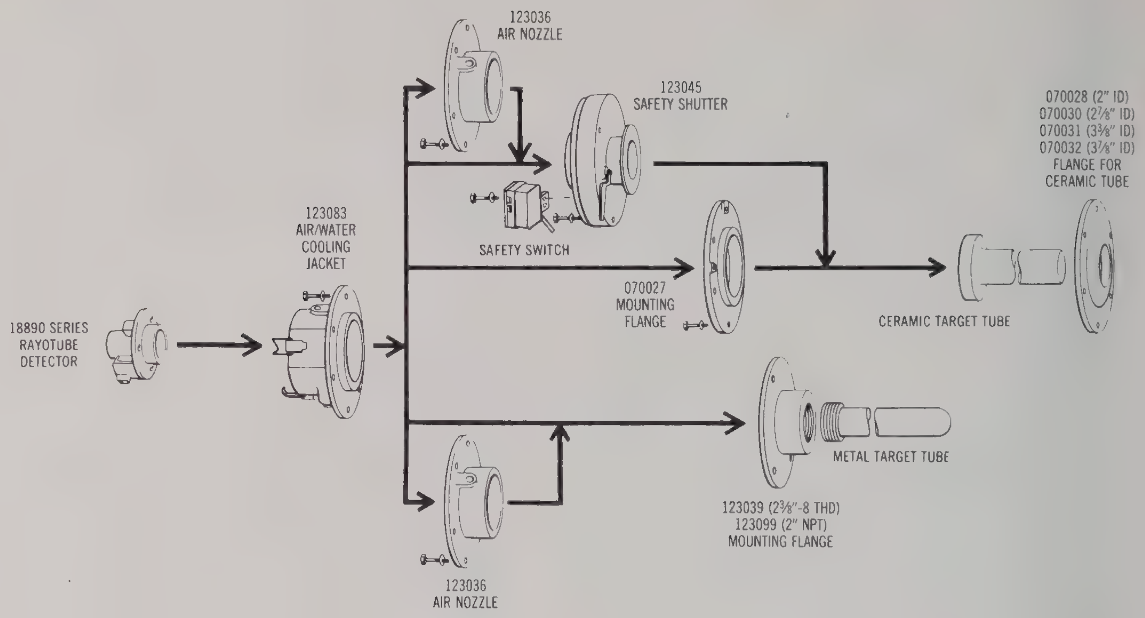
To order a Rayotube detector only, without mounting jacket or tube (for replacement, or alternative mounting arrangement), specify "18890-A-B-G-H," using appropriate suffixes from the ordering instructions above. Options G and H may be omitted.

For more information, see Data Sheet D1.3121-DS.

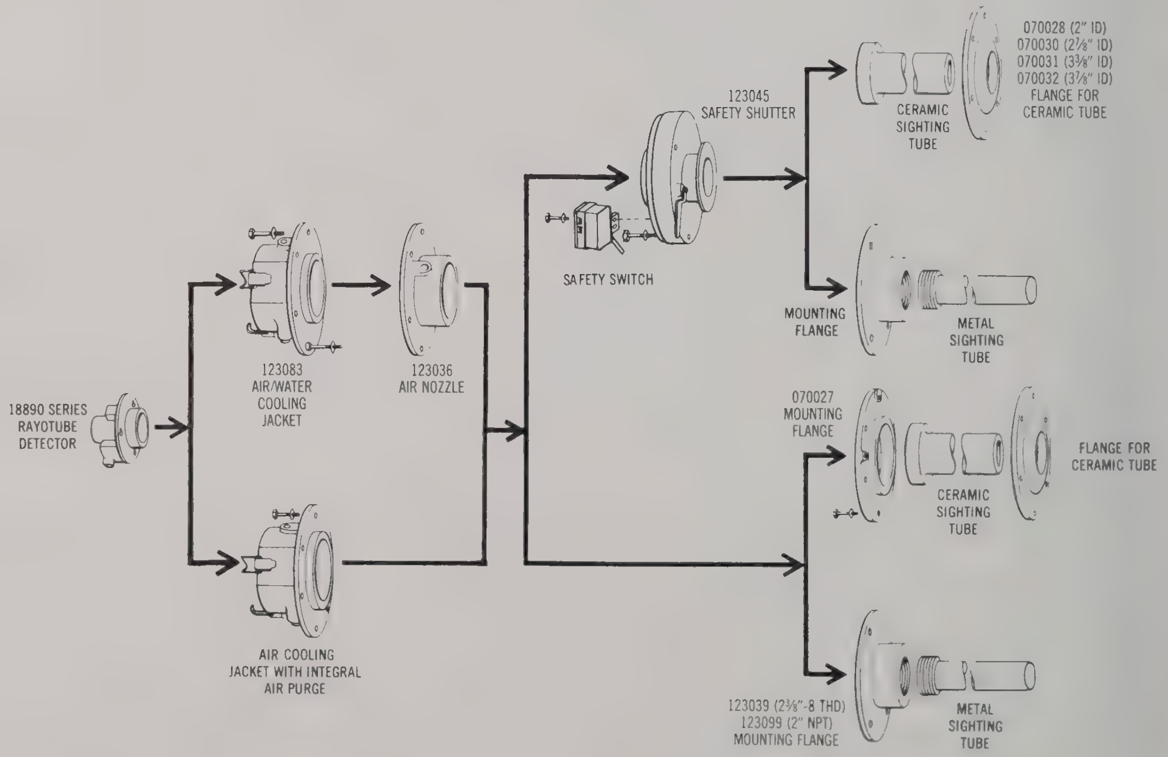
Range Table

Standard Recorder Range	Range Number (Suffix "A")	Blackbody Output, mV	Speedomax H or W Compensator	
			Range of Target Emittance*	Compensator Range, mV**
200 to 1000 F ****	0163	0.03 to 3.5	0.5 to 1.0	1 to 5
650 to 1400 F	1019	0.35 to 7.5	0.66 to 1.0 0.13 to 0.66	5 to 25 1 to 5
750 to 1600 F	3302	0.57 to 9.4	0.53 to 1.0 0.11 to 0.53	5 to 25 1 to 5
800 to 1800 F 450 to 1000 C	0073 0076	0.69 to 15***	0.33 to 1.0 0.07 to 0.33	5 to 25 1 to 5
1100 to 2300 F 600 to 1260 C	0074 3881	1.12 to 24***	0.2 to 1.0 0.04 to 0.2	5 to 25 1 to 5
1200 to 2600 F 650 to 1400 C	0035 0077			
1375 to 3000 F 750 to 1650 C	0412 0537			
1500 to 3300 F 825 to 1800 C	0075 0078			
1650 to 3600 F	1729			
1850 to 4000 F 975 to 2200 C	0643 0135			
2130 to 4600 F 1160 to 2500 C	0216 0760			
2500 to 5000 F 1250 to 2800 C	5423 2133			

**Determined by dividing the maximum millivoltage output of the Rayotube into the minimum and maximum values of the compensator range (maximum emittance can be nc greater than 1)*
***Speedomax H and W instruments have a switch-selected dual-range compensator — 1 to 5 mV and 5 to 25 mV — with a compensator dial calibrated 0-100*
****Millivolt output applies to Fahrenheit ranges, output for a corresponding Celsius range will vary slightly, since it is not an exact match*
*****Minimum focus, 9 inches*


123036
AIR NOZZLE
123045
SAFETY SHUTTER
070028 (2" ID)
070030 (2⅞" ID)
070031 (3⅜" ID)
070032 (3⅞" ID)
FLANGE FOR
CERAMIC TUBE
123083
AIR/WATER
COOLING
JACKET
SAFETY SWITCH
070027
MOUNTING
FLANGE
CERAMIC TARGET TUBE
18890 SERIES
RAYOTUBE
DETECTOR
METAL TARGET TUBE
123039 (2⅜"-8 THD)
123099 (2" NPT)
MOUNTING FLANGE
123036
AIR NOZZLE

TYPICAL ASSEMBLIES WITH CLOSED-END TARGET TUBES


070028 (2" ID)
070030 (2⅞" ID)
070031 (3⅜" ID)
070032 (3⅞" ID)
FLANGE FOR
CERAMIC TUBE
123045
SAFETY SHUTTER
CERAMIC
SIGHTING
TUBE
SAFETY SWITCH
MOUNTING
FLANGE
METAL
SIGHTING
TUBE
123083
AIR/WATER
COOLING
JACKET
123036
AIR NOZZLE
18890 SERIES
RAYOTUBE
DETECTOR
070027
MOUNTING
FLANGE
FLANGE FOR
CERAMIC TUBE
CERAMIC
SIGHTING
TUBE
AIR COOLING
JACKET WITH INTEGRAL
AIR PURGE
123039 (2⅜"-8 THD)
123099 (2" NPT)
MOUNTING FLANGE
METAL
SIGHTING
TUBE

TYPICAL ASSEMBLIES WITH OPEN-END SIGHTING TUBES

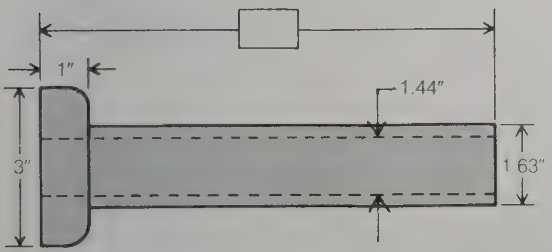
Replacement Tubes

Target & Sighting Tubes
Specifications and Part Numbers

Suffix	Material	Sketch	ID × OD	Open Sighting	Target	Length				
						12″	18″	24″	30″	36″
411 (K2022-☐)	Fyrestan	A	1.44″ × 1.63″ with collar 3″ OD × 1″	X	—	027813	027814	065544	265613	—
412 (K2012-☐)	Fyrestan	B	1.44″ × 1.63″ with collar 3″ OD × 1″	—	X	—	065224	065225	065226	
431	Alumina	A	1.44″ × 1.63″ with collar 3″ OD × 1″	X	—	027819	027820	025979	025980	
432	Alumina	B	1.44″ × 1.63″ with collar 3″ OD × 1″	—	X	027821	025973	025974	025975	
441 (K601-☐)	Inconel	C	1.39″ × 1.67″ with 044019 Fitting	X	—	065539	065540	265553	027816	—
442 (K600-☐)	Inconel	D	1.39″ × 1.67″ with 044019 Fitting	—	X	—	—	—	065426	
421 (K2213-☐)	Silicon Carbide	E	1.31″ × 2.11″ with collar 3¼″ OD × 1″	X	—	265628	265629	265630	027815	
422 (K2208-☐)	Silicon Carbide	F	1.31″ × 2.11″ with collar 3¼″ OD × 1″	—	X	—	065253	027817	027818	—
452 (K2221-☐)	Refrax	G	2.12″ × 3.16″ with collar 4¼″ OD × 1″	—	X	—	—	065652	—	265641
462 (K2350-☐)	Silicon Carbide Fyrestan Liner	H	1.65″ × 3.16″ with collar 4¼″ OD × 1″	—	X	—	—	065601	—	

Rayotube Sighting and Target Tubes

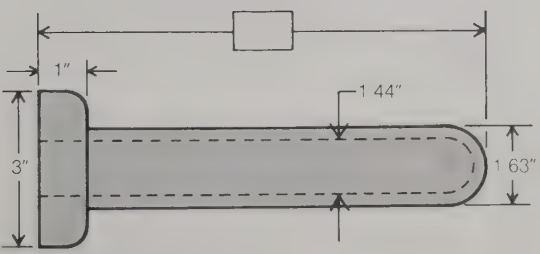
Suffix 411 Sighting Tube (Open End)
431



Material: Fyrestan (411), Alumina (431)

Figure A

Suffix 412 Target Tube (Closed End)
432

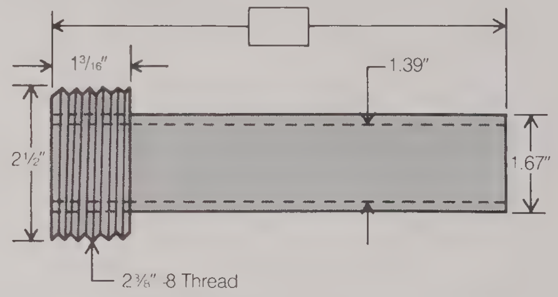


Material: Fyrestan (412), Alumina (432)

Figure B

Rayotube Sighting and Target Tubes continued

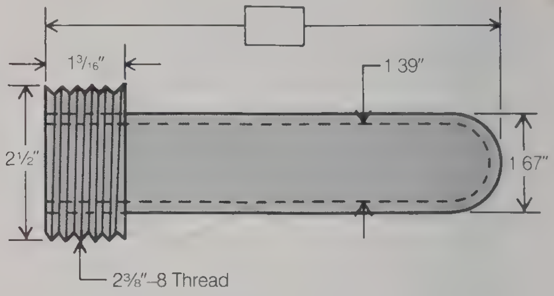
Suffix 441 Sighting Tube (Open End)


1 3/16"
1.39"
2 1/2"
1.67"
2 3/8"-8 Thread

Material: Inconel

Figure C

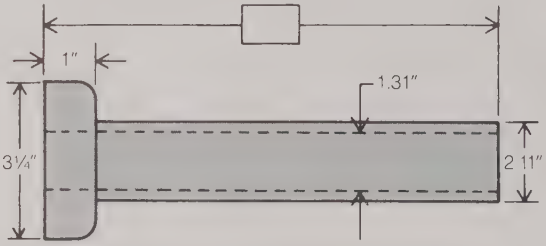
Suffix 442 Target Tube (Closed End)


1 3/16"
1 39"
2 1/2"
1 67"
2 3/8"–8 Thread

Material: Inconel

Figure D

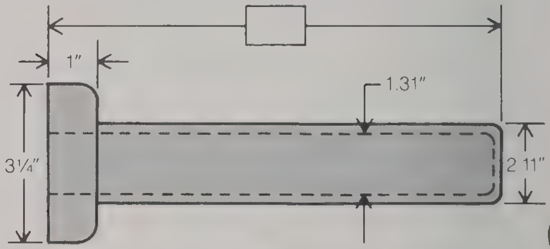
Suffix 421 Sighting Tube (Open End)


1"
1.31"
3 1/4"
2 11"

Material: Silicon Carbide

Figure E

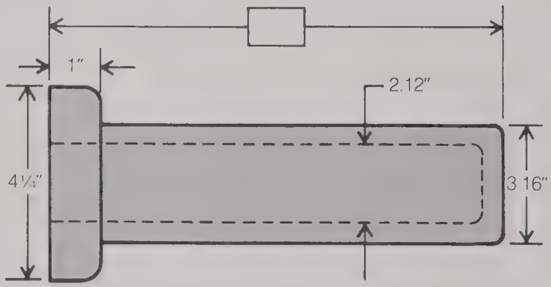
Suffix 422 Target Tube (Closed End)


1"
1.31"
3 1/4"
2 11"

Material: Silicon Carbide

Figure F

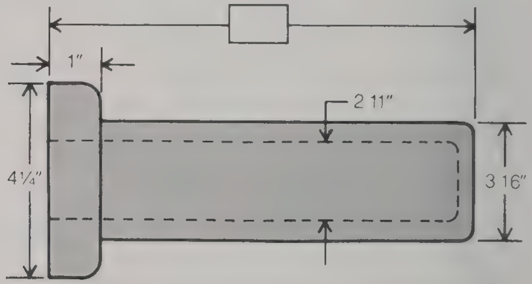
Suffix 452 Target Tube (Closed End)


1"
2.12"
4 1/4"
3 16"

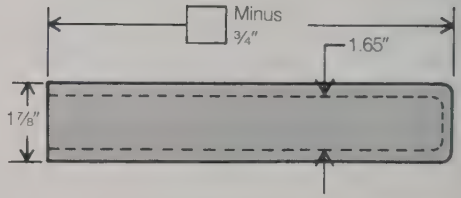
Material: Refrax

Figure G

Suffix 462 Target Tube (Closed End)


1"
2 11"
4 1/4"
3 16"

Material: Silicon Carbide


Minus 3/4"
1.65"
1 7/8"

Material: Fyrestan

Figure H

18894 and -9 Series Thin-Film Rayotube® Detectors

for glass in-depth or surface-temperature measurements

- **Non-contact continuous temperature measurement of glass depth (18894) glass surface (18899)**
- **Excellent reproducibility of measurement—ideal for control applications**
- **Thin-film thermopile for fast response; time constant of 0.015 second**
- **Small target area requirement—permits using small-diameter sighting tube**

These specialized versions of the 18890-Series Rayotube detectors were developed specifically for glass-industry applications, and differ primarily in the optical filters employed.

18894 Detector: In-Depth Measurements

The 18894 has an optical filter with a 3- to 4-micron bandpass, permitting glass-temperature measurement in depth. In soda lime glass, for example, the measured temperature results from an integrated measurement down to a depth of 0.3 inch.

An added advantage of this filter is that the measurement can be made without interference from flame or hot gases, since the spectral region is unaffected by either absorption or emission from CO_2, H_2O or the visible-flame bands.

18899 Detector: Surface Measurements

Filter characteristics of the 18899 (4- to 10-micron bandpass) permit a glass-*surface* temperature measurement. Essentially all the emitted energy contribution is from a depth integrated from 0 to 0.015". (The 18899 replaces earlier 8899 and 8899-1 Rayotube detectors, with the added features of faster response, smaller target-diameter requirements and greater signal output.)

SPECIFICATIONS

Specifications are identical to those of the 18890-Series Rayotube detectors listed on page B-96, with the following exceptions:

Range 18894: 750 to 2550 F or 400 to 1400 C. 18899: 340 to 1400 F or 340 to 1800 F.

Output 18894: 5.98 mV at 2500 F. 18899: 3.50 mV at 1400 F.

Spectral Response 18894: 3- to -4 micron bandpass. 18899: 4- to 10-micron bandpass.

For more information, contact your local L&N Field Office.

HOW TO ORDER

Specify basic catalog number and appropriate suffixes.

A B C D E
1889☐-☐☐☐☐-☐☐☐-☐☐☐-☐☐☐-
F G H
☐☐☐-☐☐☐-☐☐☐

Basic Catalog Number	
For In-Depth Measurements	**18894**
For Surface-Temperature Measurements	**18899**
Suffix A. Range	
18894:	
750 to 2550 F	**0579**
400 to 1400 C	**0578**
18899:	
340 to 1400 F	**1217**
340 to 1800 F	**8814**
Suffix B. Focus	
7 to 12 Inches	**109**
12 to 16 Inches	**113**
16 to 24 Inches	**118**
24 Inches to Infinity	**124**
Suffix C. Mounting	
Air/Water Cooling Jacket	**31**
Air/Water Cooling Jacket with Air Purge (Nozzle)	**33**
Air Cooling Jacket with Integral Air Purge	**32**
Suffix D. Mounting Safety Features	
None	**0**
Safety Shutter (For Ceramic Tubes Only)	**1**
Safety Shutter and Safety Switch (For Ceramic Tubes Only)	**2**
Suffix E. Sighting Tube	
Fyrestan (1.44" ID, 1.63" OD)	**411**
Silicon Carbide (1.31" ID, 2.11" OD)	**421**
Hi-Purity Alumina (1.44" ID, 1.63" OD)	**431**
Inconel 600 (1.39" ID, 1.67" OD)	**441**
Suffix F. Tube Length	
12 Inches	**512**
18 Inches	**518**
24 Inches	**524**
30 Inches	**530**
Suffix G. Options	
(Omit Suffix if Not Required)	
Unsealed Millivolt Adjustment Screw	**601**
Mounting Flange for Glass-Feeder Applications	**602**
Direct-Viewing System	**603**
Suffix H. Tagging	
(Omit Suffix if Not Required)	
1 Linen Tag (Specify Legend)	**206**
1 Aluminum Tag, Machine-Stamped, 15 Characters Max. (Specify Legend)	**207**
1 Stainless Steel Tag, Electro-Etched, 22 Characters Max. (Specify Legend)	**208**

8885 Spectray® Temperature Detectors

for non-contact continuous temperature measurements

- **Measurement capability from 800 to 3000 F.***
- **Excellent reproducibility of measurement.**
- **Fast response — time constant less than 0.001 second.**
- **Small target-area requirement.**
- **Rugged construction — to withstand heavy industrial usage.**

Designed for temperature measurements in a wide range of industrial applications, the L&N Spectray Temperature Detectors provide fast response, excellent stability, and economical performance. Responding to *radiant energy*, they are ideally suited for applications where physical contact is difficult or impossible. Some typical applications are temperatures of molten-metal streams, slabs, billets, blooms, skelp, continuous strip and casting operations and various parts being heated by induction and electronic elements.

The detectors respond to a narrow spectral band, eliminating common inaccuracies attributed to the presence of carbon dioxide and water vapor in the atmosphere between detector and target. This selectivity also reduces the errors caused by emittance variations by approximately 3 to 1 over a total-radiation device. To protect the sensitive element and optics from vapor, fumes and dust, the units are hermetically sealed at both the viewing lens and window.

**Higher ranges available on special order*

SPECIFICATIONS

Effective Wavelength 8885: 0.65 micron. 8885-1, 8885-2: 0.90 micron.

Response 0.001 second to 99% of instantaneous change.

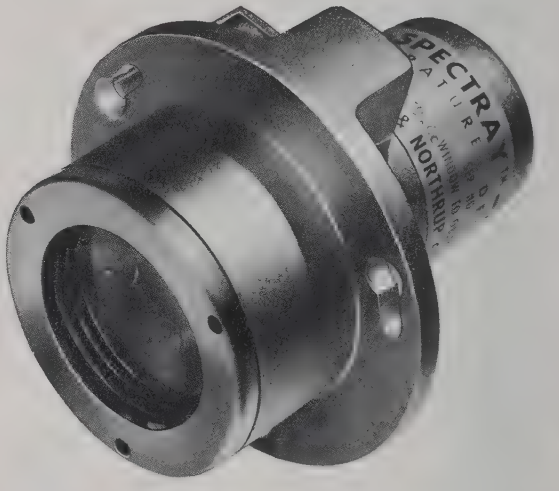
Resistance Approximate: 8885, 10 K ohms; 8885-1, 8885-2: 8 K ohms.

Target Size (Minimum Diameter) T = X(D + 2.5), where T = target diameter in inches; X = 0.011 for 8885 and 8885-1, and 0.068 for 8885-2; and D = distance from window to target in inches.

Focus Focus is fixed as specified

Case Brass alloy, nickel plated, hermetically sealed. Covered terminal block for leadwire connections

Pressure Limitation 40 psig (275 kPa), maximum.



HOW TO ORDER

Select the desired Spectray and add to the catalog number a suffix from the table below, corresponding to the window-to-target distance.

Window-to-Target Suffix			
8885, 8885-1		8885-2	
Distance, Inches	Suffix	Distance, Inches	Suffix
12-15	12	9	9
16-23	18	10-12	11
24 or more	24	13-17	14
		18 or more	18

STANDARD RECORDER RANGES FOR USE WITH SPECTRAY

Recorder Temp. Range	For Use with Spectray #	Spectray Blackbody Output (MV)
2250 to 3000 F	8885	1.12 to 24.0
2140 to 2800 F		0.54 to 11.7
1940 to 2500 F		0.18 to 3.81
1700 to 2300 F	8885-1	1.12 to 24.0
1600 to 2200 F		0.62 to 13.36
1520 to 2050 F		0.34 to 7 22
1410 to 1900 F		0.17 to 3.57
1320 to 1750 F		0.07 to 1.57
1065 to 1400 F	8885-2	1.12 to 24.0
1925 to 1200 F		0.21 to 4.48
865 to 1100 F		0.08 to 1.64

For information on mounting assemblies and sighting tubes, consult your local L&N Field Office.

For more information see Data Sheet D1.3113-DS

8886 Lens Spectray® Temperature Detectors

adjustable focus for clear sighting on cold and/or small diameter targets

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- **Clear-through sighting permits focusing on cold targets.**
- **Ideal for use with small diameter targets.**
- **Fast response, excellent reproducibility, minimum maintenance.**
- **Rugged construction . . . simple operation.**
- **Hermetically sealed.**
- **Adjustable focus.**

Because Spectray Spectrally-Selective Temperature Detectors respond to *radiant energy,* they are ideally suited for applications where physical contact is difficult or impossible.

Utilization of an objective lens permits most efficient use of the sighting path, and because the direct-image viewing system provides precise and clear viewing of the target, the unit can be easily aligned and focused even without the presence of the hot target.

A Polaroid filter assembly providing continuously variable density positions from bright to blocking permits sighting on bright as well as dim targets, and eliminates errors caused by ambient light entering the operator sighting port.

The single primary lens permits sighting on small target diameters, and the Lens Spectray is especially useful in determining temperatures in epitaxial reactors, crystal growing, vacuum melting and induction heating furnaces and other narrow sight-tube applications.

Two objective lenses are available. One is for applications where target distance is between 24" and infinity; the other for 12" to 23". Although these units are hermetically sealed to protect the sensitive element and optics from vapor, fumes and dust, they can be easily refocused in the field.

SPECIFICATIONS

Catalog Numbers 8886-☐ Effective wavelength 0.65 Microns. 8886-1-☐ Effective wavelength 0.90 Microns.

Type Spectrally-selective radiation-type temperature detector. Narrow angle single lens optical system with direct-image viewing system.

Resistance Approx. 8000 ohms.

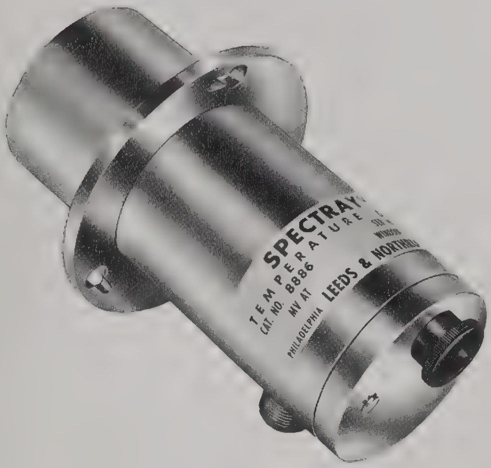
Response 0.001 second to 99% of instantaneous change.

Ambient Temperature 32 to 250 F (0 to 120 C).

Maximum Pressure 40 psi (275 kPa).

Case Approximately 2¼" (excluding mounting flange) in diameter by 6" in length. Brass, nickel-plated. Hermetically sealed.

Connections Two conductor MIL SPEC hermetic seal receptacle and mating connector for output termination.



Focus For targets 24" to infinity, factory focused at 24", field adjustable to infinity.

For targets 12" to 23", factory focused to nearest inch desired.

Minimum Target Diameter is determined by the formula

T = 0.025 (D/f), where
D = Focus Distance
f = focal length of objective lens which is:
3.165 if focus distance is less than 24",
3.670 if focus distance is 24" or greater.

Insert Focus Distance in suffix block.

Standard Recorder Ranges for Lens Spectray

Recorder Temp. Range	For Use with Lens Spectray:	Blackbody Output (MV)
2250 to 3000 F 2140 to 2800 F 1940 to 2500 F	8886	0.84 to 17.98 0.41 to 8.78 0.13 to 2.86
1770 to 2350 F 1600 to 2200 F 1520 to 2050 F 1410 to 1900 F 1320 to 1750 F	8886-1	0.87 to 18.0 0.47 to 10.02 0.25 to 5.42 0.12 to 2.68 0.05 to 1.18

HOW TO ORDER To order the Lens Spectray with specialized mounting assemblies and sighting tubes consult your local L&N Field Office.

For more information, see Data Sheet D1.3116-DS.

8888 Linearizer-Plus for Radiation Temperature Detectors

- **Converts non-linear output of Rayotube or Spectray detector to linear analog or digital signal**
- **Field-selectable instantaneous, averaging or peak-picking readout of input signals**
- **Optional front-panel LED digital display**
- **Optional alarms, digitally set, with field-selectable high or low alarm mode**
- **Fixed or adjustable alarm dead band**
- **Choice of voltage output ranges — 0-100 mV, 0-25 mV or 0-1 V d-c — with optional simultaneous current output, 0-20 or 4-20 mA d-c**
- **Wide choice of temperature ranges**
- **Field selectable F or C calibration**
- **Optional digital (BCD) output signal**
- **Long-term stability and repeatability**

The L&N 8888 Linearizer-Plus is a high-performance panel-mounted instrument — featuring state-of-the-art electronic circuitry — designed to convert the non-linear signal output of an L&N Rayotube or Spectray heat-radiation detector to a linear signal.

The Linearizer can be used as a self-contained indicator, with measured temperature read on an LED digital display on the front panel and optional alarm or on-off control actions; or it can function as a transmitter, supplying a linear analog output — voltage or current — to a recorder or controller equipped with a linear chart and scale, providing improved resolution over the entire temperature range

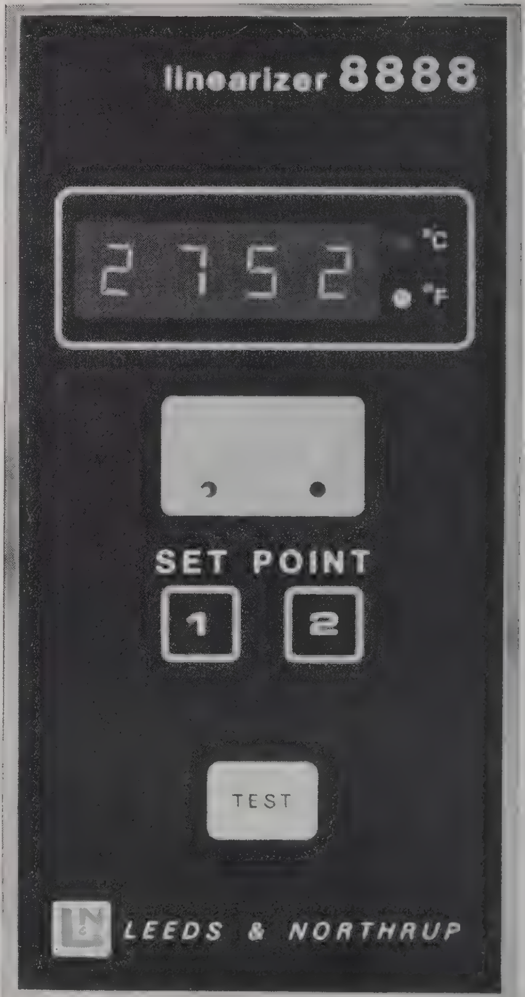
An optional isolated BCD output signal is available to interface with auxiliary data storage equipment such as printers, magnetic tapes, teletypes and computers

FUNCTION PROGRAMMING

A readily accessible Function Programming printed-circuit card mounts the Function Selector (a group of slide switches), various optional rotary switches (digisetters) for setting values, and the optional Emissivity Compensator.

TEMPERATURE READOUT AND FUNCTIONS

When digital display of measured temperature is provided on the front panel, readout can be °F or °C. switch-selected. (Selection is indicated by an LED on the front panel adjacent to "°F" or "°C".) All functions, including the digital alarm settings, are automatically transferred to values in the selected units



8888 Linearizer-Plus (shown actual size) features optional LED digital display of measured temperature, LED alarm indication, and pushbuttons for digital display of set points

To check the digital display, the "TEST" button is pressed, and all segments of the LED display should light ("8888"), plus the LEDs for alarms, "°F" and "°C

MEASUREMENT

Measurement can be instantaneous, averaging or peak-picking — all standard features on the 8888, and selected by the Function Selector Switch and digital settings of the Measurement Function Rotary Switches

Instantaneous: The Linearizer will read out at sampling rate (20 pps, average).

Averaging: The Linearizer will read out, at 1-second intervals, the average value of the preceding period — up to 99 seconds.

This function is used when instantaneous temperature is not of interest: typical applications are in process start-up, in heat-treating, annealing and stress-relieving of metals, in soaking pits, drying ovens, etc.

Peak-Picking: During each period (from 1 to 9 seconds) the Linearizer will read out the *higher* of two values: either (a) the highest actual temperature (peak) measured in the preceding period, or (b) a temperature value below the last readout, limited by the decay rate — 1 to 9% of the last peak temperature span.

Example: Assume a range span of 1000-3000 F, and a decay rate of 5%. If, in one period, peak temperature was 2000 F, decay would be 0.05 (2000 F − 1000 F) = 50 F°. During the *second* period, readout would be 2000 F; if peak temperature during this period did not exceed 1950 F (2000 F − 50 F), readout during the *third* period would be 1950 F. Readout would continue to decrease by 50 F° each period, until a period was reached in which measured temperature peaked above the decay limit and established a new cycle.

For more information see Data Sheet D1.3131-DS.

SPECIFICATIONS:

INPUT

Input Signal: Accepts continuous non-linear millivoltage input signal from Rayotube or Spectray heat-radiation detector.

Ranges: For standard ranges, see "Range Table."

Input Impedance: 50 megohms.

Maximum Overload: 600 mV.

Emissivity Compensator: Optional emissivity dial — 10-turn potentiometer continuously adjustable from 0.2 to 1 — permits field-calibration for a non-black-body source.

OUTPUT

Analog Output: Standard: 0-100 mV d-c, non-isolated, into 1000-ohm minimum load.

Optional: O-1 V d-c, non-isolated, into 1000-ohm minimum load, or 0-25 mV d-c, non-isolated, into 200-ohm minimum load. A simultaneous isolated 0-20 or 4-20 mA d-c output into a 500-ohm maximum load can also be provided.

Accuracy varies with range span (see "Range Table").

Digital Output: Optional isolated BCD output, compatible with TTL or CMOS, can be provided. A mating connector for the terminal outlet at the rear of the case is included.

Digital Display: Optional illuminated digital display of temperature readout on front panel: four-digit seven-segment LED numerals, 0.3" high. "F" or "C" light identifies calibration. Accuracy, ±2 or ±3 C° (±4 or ±6 F°), according to range. "Test" pushbutton lights all LED segments for checking.

Alarms: Optional alarms may be one or two SPDT contacts, as specified, rated at 1 A max., 250 V max.; 250 VA or 100 W max., switched power (resistive). Low or high alarm mode is field-selectable. Each alarm is digitally set, using four 10-point rotary switches. When digital display option is specified, depressing the alarm switch ("1" or "2" on the front panel) will display the alarm setting.

Overrange: An SPDT contact (same rating) is included which is energized when the measurement exceeds the upper or lower limit of the specified range, to operate an external alarm, etc. Analog output signals will be −1% of full-scale output for underrange condition, 101% for overrange. The optional digital display (or BCD output) will read "0000" for underrange, "9999" for overrange.

PERFORMANCE

Linearization: Up to 40 variable-length-segment digital linearization, using a microprocessor.

Measurement Method: Dual-slope 12-bit A/D converter, with solid-state chopper-stabilized preamplifier; auto-ranging is used to increase accuracy at the low end of the range.

Measurement Readout: Selectable, as standard feature: instantaneous, averaging, or peak-picking.

Instantaneous: Readout at sampling rate (20 pps, average).

Averaging: Readout, at 1-second intervals, of the average value during the selected preceding period (1 to 99 seconds).

Peak-Picking: Readout at selected intervals (1 to 9 seconds) of the higher of two values: (a) the highest actual temperature (peak) measured in the preceding period, or (b) a temperature value below the last readout, limited by the decay rate — 1 to 9% of the last peak temperature span.

Sampling Rate: 15 to 25 points per second, according to input value (average, 20 pps).

Response Time: 1 second to 90% of final value, for display and output.

Resolution: ± 1.0° F or C.

Stability: Short Term: Better than 0.2 μV in 36 hours
Long Term: Better than 5 μV (or 1 digit) in 6 months
With Temperature: Better than 0.2 μV per degree C

OPERATING INFLUENCES

Operating Temperature Limits: 0 to 50 C (32 to 122 F)

Storage Temperature Limits: −20 to 70 C (−4 to 168 F).

Relative Humidity Limit: 90% R.H., non-condensing

Vibration Limit: 0.2 g at 6 to 60 Hz

POWER REQUIREMENTS

Power Supply: Fused 120 V or 220/240 V, 50/60 Hz, 20 VA max; voltage capability is field-selectable by toggle switch at rear of case.

Terminal Connections: Screw-type, at rear of case

CONSTRUCTION

Case: NEMA 12 dust-tight aluminum case, with black front panel.

Dimensions: 72 mm (w) × 144 mm (h) × 485 mm (d) (approximately $2^{13}/_{16}$" × $5^{11}/_{16}$" × 19⅛"). Panel cutout: 68 mm × 138 mm (approximately $2^{11}/_{16}$" × $5^{7}/_{16}$")

Weight: 5 kg (11 lb), net

HOW TO ORDER

Specify appropriate suffixes to complete the catalog number.

```
      A B C D E   F      G
8888-2-☐-3-0-0-☐☐☐☐-011-☐☐☐
```

Suffix A. Display	
Digital Temperature Readout (Includes Provisions for LED Alarm Indication)	**2**
Suffix B. Alarms	
None	**0**
Two SPDT Alarms; High or Low, Switch-Selectable	**2**
Suffix C. Analog Output(s)*	
0-100 mV and 4-20 mA D-C	**3**
Suffix D. Digital Output	
None	**0**
Suffix E. Power Requirements**	
120 V, 50/60 Hz	**0**
Suffix F. Range	
Specify Appropriate Range Number from Range Table	☐☐☐☐
Suffix G. Options	
Emissivity Compensator	**011**
Adjustable Alarm Deadband (Supplied with Alarms)	**012**

**Voltage outputs is non-isolated, current outputs is isolated.*

***The 8888 Linearizer-Plus operates on either 120 V or 220/240 V; a selector switch on the rear of the case adapts the unit to the available supply.*

RANGE TABLE

Detector Type*	Output, mV	Temperature Range	Display Accuracy**	Range Number (Suffix F)
8845 Rayotube	0-40 91 0-40 30	25- 540 C 77-1000 F	±3 C° ±6 F°	0045*** 0145***
18890 Rayotube	0 03- 3 50	200-1000 F	±4 F°	8800****
	0 35- 7 50	650-1400 F		8801
	0 57- 9 40	750-1600 F		8811
	0 69-15 00	800-1800 F		8802
	1 12-24 00	1100-2300 F		8803
	1 12-24 00	1200-2600 F		8804
	1.12-24.00	1375-3000 F		8805
	1 12-24 00	1500-3300 F		8806
	1 12-24 00	1650-3600 F		8807
	1 12-24 00	1850-4000 F		8808
	1 12-24 00	2130-4600 F		8809
	1 12-24 00	2500-5000 F		8810
18894 Rayotube	0.155-5.98	750-2550 F 400-1400 C	±4 F°	8813
18899 Rayotube	0.162-5.607	340-1800 F	± 4 F°	8814
8885 Spectray	0.07-24.18 0.13-24.00	1000-1650 C 1900-3000 F	±2 C° ±4 F°	6078 6079
8885-1 Spectray	0.06-26 04 0.15-24.00	700-1300 C 1400-2350 F	±2 C° ±4 F	5151 4151
8885-2 Spectray	0.052-24.00 0.061-24.00	450- 760 C 850-1400 F	±3 C° ±6 F	7078 7079
8886 Spectray	0.05-23.88 0.19-24.45	1000-1700 C 2000-3100 F	±3 C ±6 F°	8078 8079
8886-1 Spectray	0.04-19.57 0.11-25.76	700-1300 C 1400-2450 F	±3 C ±6 F°	8178 8179

**The 8888 Linearizer-Plus can be retrofitted to most Rayotube and Spectray detectors already in service, including 8890, 8891, 8891-C, 8893, 8896 and 8898 Rayotube detectors (now replaced by the 18890) For details, contact your local L&N Field Office*

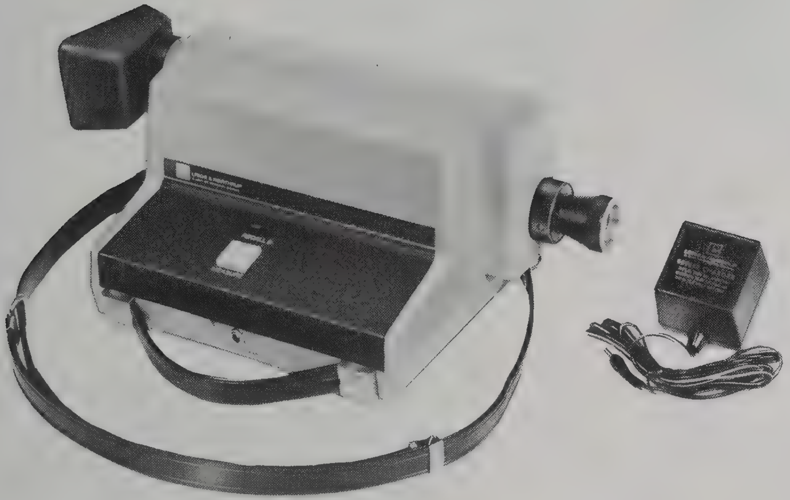
***Analog Output-Signal Accuracy equals Display Accuracy at 25 C ambient temperature, ±0 02% of range span per degree C change from ambient*

****Requires use of external 152056 Compensator*

*****Emissivity compensation is limited from 0 5 to 1*

NOTE For any detector range, the 8888 Linearizer-Plus can display the temperature in either F or C (switch-selected

8646 Automatic Optical Pyrometer



- **Microprocessor-based, self-balancing, disappearing-filament type**
- **Direct-sighting on target through telescope**
- **Digital display of measured temperature in the field of view, from 800 to 3000 C (1472 to 5432 F)**
- **High stability and reproducibility of measurement**
- **Recall of last temperature display, switch-selected**
- **Peak-picking or continuous measurement, switch-selected**
- **F or C display, switch-selected**
- **Digital setting of emissivity, from 0.20 to 1.00, for true temperature readings**
- **Self-diagnostic displays to simplify service and maintenance**
- **Rugged industrial design**

A significant advancement in non-contact temperature measurement, the 8646 Automatic Optical Pyrometer combines the power and versatility of a microcomputer with the disappearing-filament method—long recognized in both plant and laboratory as the most stable and reproducible technique for temperature measurements of incandescent objects or surfaces.

Providing exceptional measuring speed, reliability and simplicity of operation, the 8646 offers the ruggedness essential for industrial applications with the precision of a laboratory instrument.

The operator merely sights through the telescope, aligning the vertical lamp filament and a horizontal marker with the target; when he presses the "MEASURE" button on the base, the temperature—in C or F—is brightly displayed in the field of view, right below the target image.

Since distance has no effect on accuracy (if the target is large enough), the operator can normally keep safely away from the heat source; however, he can also move in momentarily for a quick measurement when necessary, then use the "RECALL" switch to recall the temperature display in the telescope at his convenience.

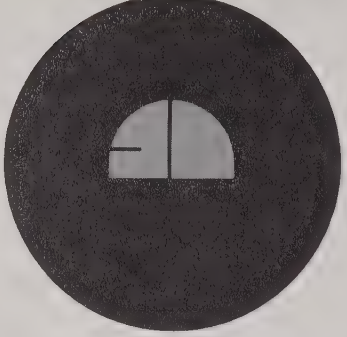
Typical industrial applications are the measurement of tapping, teeming and pouring temperatures of molten metals; temperatures of ingots, forgings, blooms and sheets, while being worked; temperatures of roofs, walls of flue linings of kilns, ovens or furnaces; glass temperatures; or any surface temperatures beyond the range of thermocouples or similar detectors.

Capable of measuring incandescent objects as small as 0.016 inch in diameter, the 8646 is also adaptable to laboratory research and engineering tests, and can be used as a thermometric standard for calibrating other types of high-temperature pyrometers.

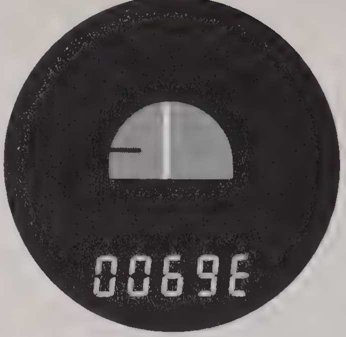
THE PRINCIPLE

The 8646 Pyrometer utilizes the "disappearing-filament" method of operation—the method used to realize the International Practical Temperature Scale above the melting point of gold, 1064.4 C; the same method used by the National Bureau of Standards

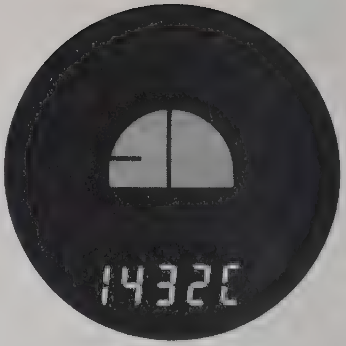
When the operator sights through the telescope and presses the "MEASURE" button, the glowing tungsten filament is superimposed upon the target image. This



1. With the vertical lamp filament and a horizontal marker centered on the target, the operator presses and holds the "MEASURE" button . . .



2. causing a current surge to brighten the filament, and the emissivity setting to be momentarily displayed in the LEDs . . .



3. followed by the measured temperature, as the filament brightness is matched to the target (for the sensor, but not the eye).

combined image is also projected on a scanning-array sensor, which electrically scans across the dual image. The microcomputer increases or decreases the current through the filament to achieve a brightness match, as detected by the sensor. (The filament may *not* disappear to the eye, which has a different response than the sensor.) Current is simultaneously converted to a temperature reading, which is digitally displayed in the LEDs below the target image.

Since this is essentially a null-balancing procedure, the stability and accuracy of the 8646 Pyrometer depend only on the calibrated tungsten lamp, and are independent of the stability of the sensor. And since the measurement is completely automatic, it eliminates the possible variations in readings made by different operators under the same conditions.

For more information see Data Sheet B1.4125-DS.

SPECIFICATIONS

Catalog Number 8646 Automatic Optical Pyrometer.

Type Automatic disappearing-filament brightness pyrometer, with digital readout in field of view.

Ranges Three (C or F), manually selected by rotating knurled ring at base of objective lens to detent positions: "L" (low), "M" (medium) or "H" (high) range.
Low Range: 800 to 1200 C/ 1472 to 2192 F.
Medium Range: 1200 to 1800 C/ 2192 to 3272 F.
High Range: 1800 to 3000 C/ 3272 to 5432 F.

Accuracy of Range Referenced to 25 C (77 F) ambient temperature and blackbody conditions. Low Range: ±0.66% of upper range limit. Medium Range: ±0.88% of upper range limit. High Range: ±1.2% of upper range limit.

Resolution 1 degree C or F.

Repeatability
Celsius Ranges:
Low: 800 to 900 C, 4 C°; 900 to 1200 C, 2 C°
Medium: 1200 to 1300 C, 7 C°; 1300 to 1800 C, 3 C°
High: 1800 to 2000 C, 13 C°; 2000 to 3000 C, 6 C°
Fahrenheit Ranges:
Low: 1472 to 1652 F, 8 F°; 1652 to 2192 F, 4 F°
Medium: 2192 to 2372 F, 14 F°, 2372 to 3272 F, 6 F°
High: 3272 to 3672 F, 26 F°; 3672 to 5432 F, 12 F°

Display Five LEDs, approximately ⅜" high, available for display in field of view.
(a) Temperature: Three or four digits, as required, plus "C" or "F" (e.g., "1275C").
(b) Emissivity Setting: Three digits with decimal point, plus letter "E" (e.g., "0.69E").
(c) Coded Displays: Overrange ("9999H"), underrange ("1111L"), low battery, and other diagnostic displays.

Ambient Temperature Limits 0 to 50 C (32 to 122 F), for rated operating conditions.

Power Supply 12.5 V d-c, nominal, provided by 10 AA-size Ni-Cad rechargeable batteries in a pack.

Battery Charger Provided with the 8646 or 8646-B Pyrometer, for charging batteries while in the internal battery pack. Connects to receptacle on the Pyrometer. Charging time, 6 hours; output, 14.5 V d-c at 100 mA. Operates on 120 V, 50/60 Hz.*

Weight Approximately 5.5 lb (2.5 kg).

**A separately-ordered 051093 Battery Charger is also available, for operation on 205-255 V, 50/60 Hz*

HOW TO ORDER

The Automatic Optical Pyrometer is specified by a 6-digit Part Number, which includes the 8646 (or 8646-B), ten AA Ni-Cad batteries, Battery Charger for 120-V operation, and an Adapter Cable for use with an optional Battery Pack Holder (separately ordered).

050300 8646 Automatic Optical Pyrometer

051845 8646-B Automatic Optical Pyrometer
Includes L&N Letter of Calibration (directly traceable to N.B.S.) with correction data.

Optional Accessories

054799 Objective Lens 2" focal length. Recommended for use on targets at distances from 7" to 24"; minimum target size, 0.08" at 7", 0.38" at 24".*

054797 Objective Lens 1.5" focal length. Recommended for use with very small targets at distances from 2" to 6"; minimum target size, 0.016" at 2", 0.15" at 6".*

046767 Battery Pack Holder For recharging batteries external to the Pyrometer. (Batteries not included.)

051093 Battery Charger Output, 14.5 V d-c at 100 mA: operates on 205-255 V, 50/60 Hz.

**Based on $T = K(S-F)$, where*
T = Target Diameter, in inches
K = 0.017 for 2" focal length,
0.033 for 1.5" focal length
S = Distance to Target, in inches
F = Focal Length, in inches

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LEEDS & NORTHRUP
INSTRUMENTS
A UNIT OF GENERAL SIGNAL

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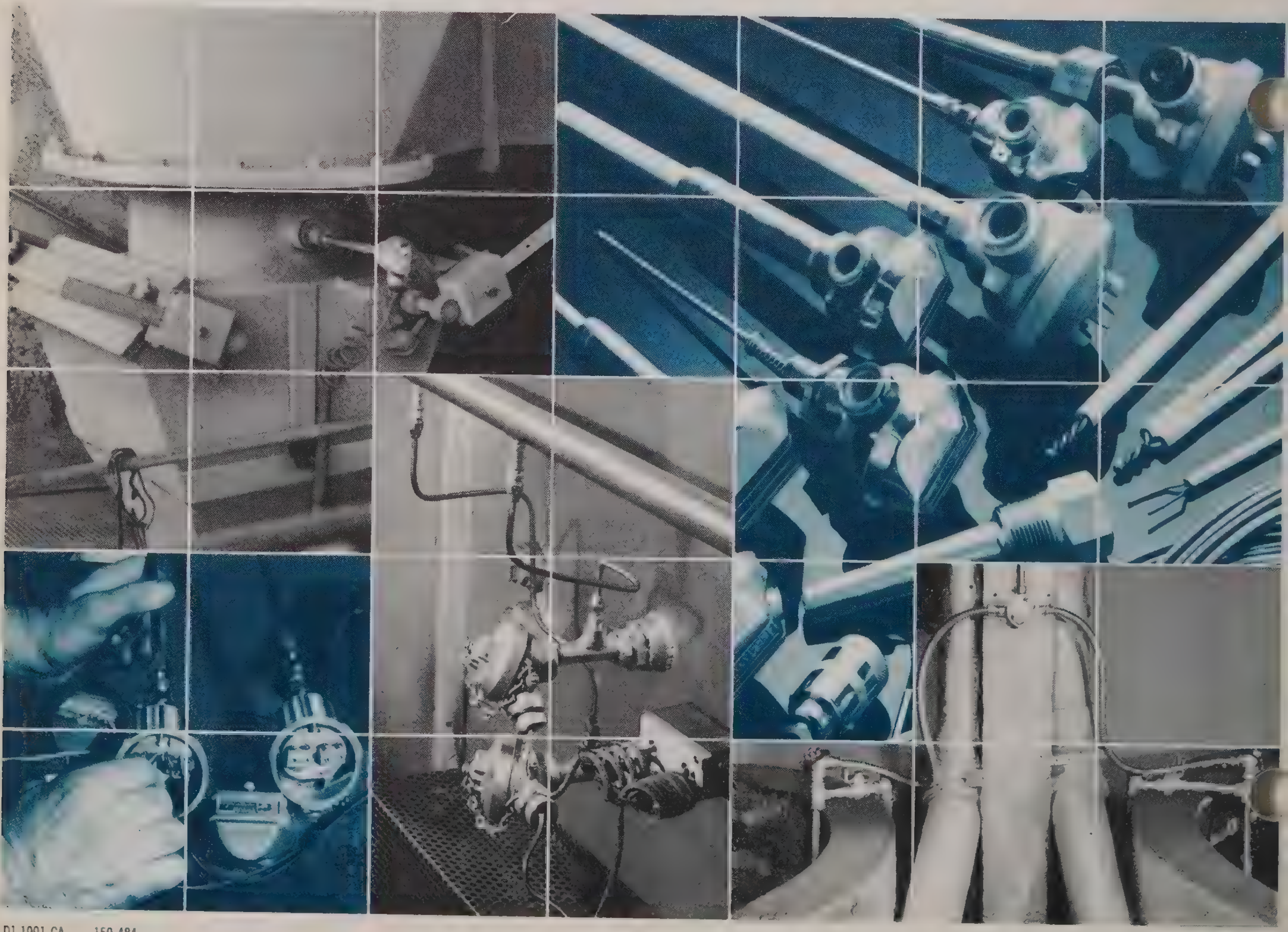

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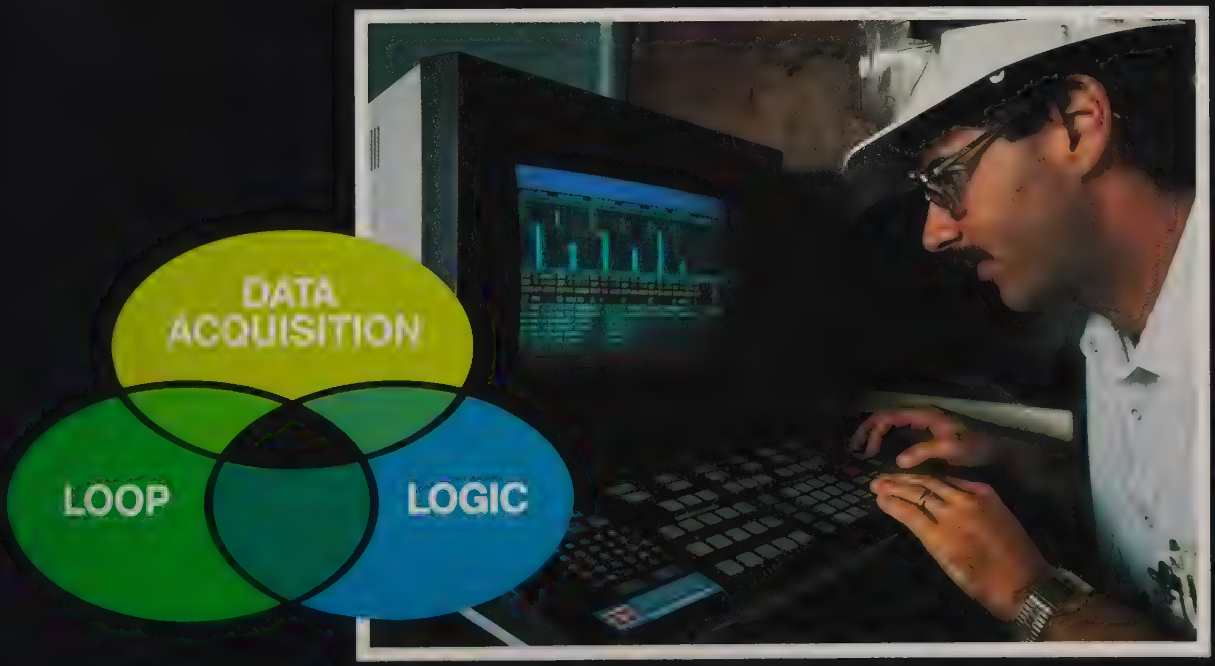
MICROMAX®

Process Management System


DATA ACQUISITION
LOOP
LOGIC

LEEDS & NORTHRUP
A UNIT OF GENERAL SIGNAL

Conventional control schemes for industrial processes are segmented by tasks, with these tasks assigned to individual pieces of equipment. Recorders measure and display process data. Loop controllers regulate variables such as temperature, flow and pressure. Programmable logic controllers both initiate and respond to process events, tripping relays, timing out sequences, etc. Each is concerned with just one aspect of the automation of a process. But since they do affect each other, there must also be interfaces to coordinate their activities. And if centralized supervision or direction is a requirement, a computer has to be added to the automation package.

Such configurations can and do maintain control over a process—after a fashion. They are hardly optimum solutions. Fitting together different hardware and software components inevitably means compromise. Working with several suppliers presents its own set of problems. Not to mention training operator personnel. Or stocking parts. And, with all the interfaces that are needed, it can get to be a fairly expensive proposition. Yet, despite its drawbacks, this is the way you've had to go. Efficient or not. Expensive or not.

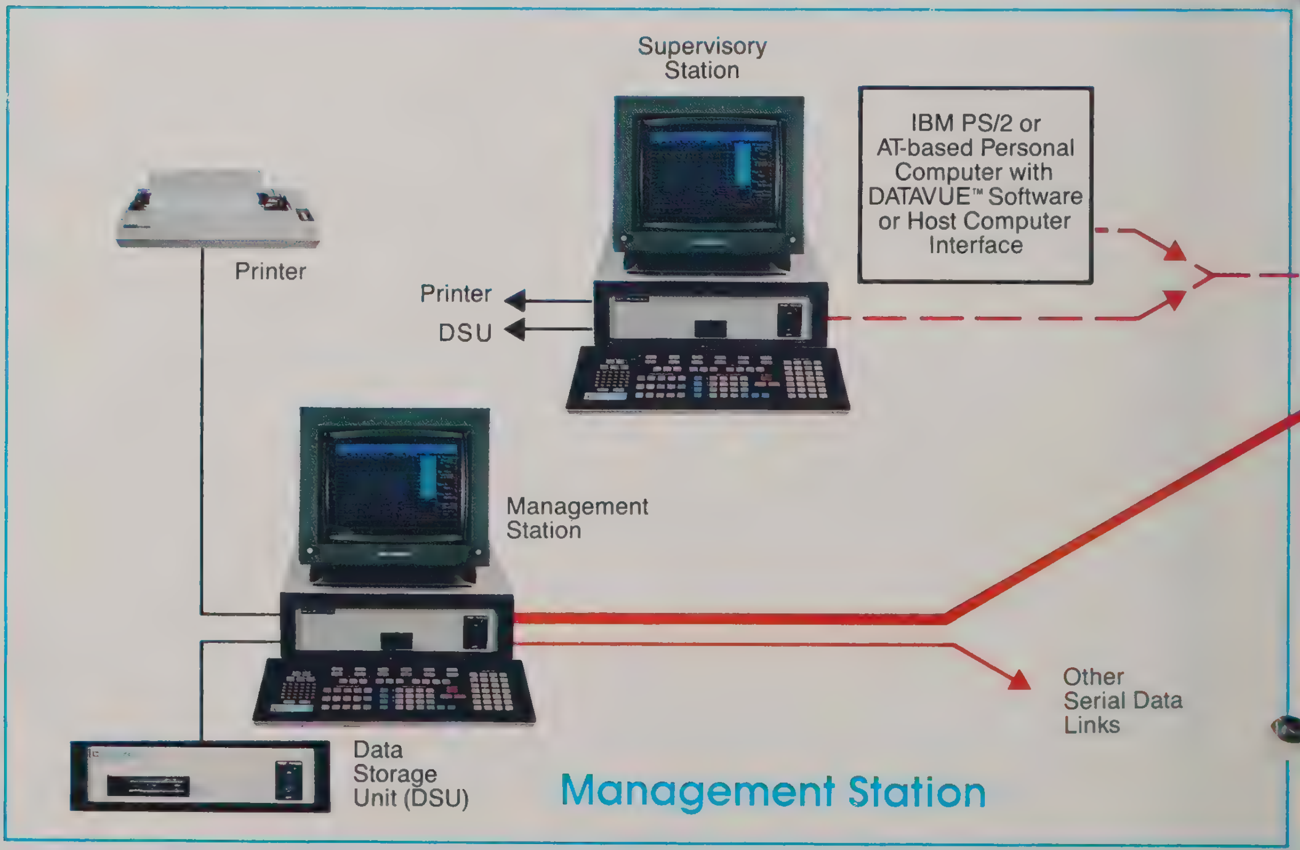
Until now.

A new and better idea

It's called the MICROMAX Process Management System and it's our approach to achieve total control over a process. Not simply a spinoff or extension of anything else we offer, the MICROMAX project began with a clean sheet of paper. A totally new concept in process management, the MICROMAX Process Management System is suitable for both batch and continuous processes. It consolidates all the various operating requirements of a process into a single package, integrating data acquisition together with control execution, including both loop and logic functions. The result is a powerful tool for improving productivity, regardless of the application.

The synergistic effect of this integration of tasks in the MICROMAX control scheme provides significant economic and performance advantages over other control techniques. The continuous interaction of functions makes possible a degree of control over the process which simply cannot be attained using individual instruments dedicated to specific tasks. And since the MICROMAX Process Management System can be closely sized to each application, it's affordable for virtually any process, small or large, simple or complex.

Typical MICROMAX Process Management System



What is it?

Basically, a MICROMAX Process Management System is composed of a Management Station and one or more Field Stations, with the primary component of each Field Station being a Local Processing Unit. MICROMAX can be configured into:

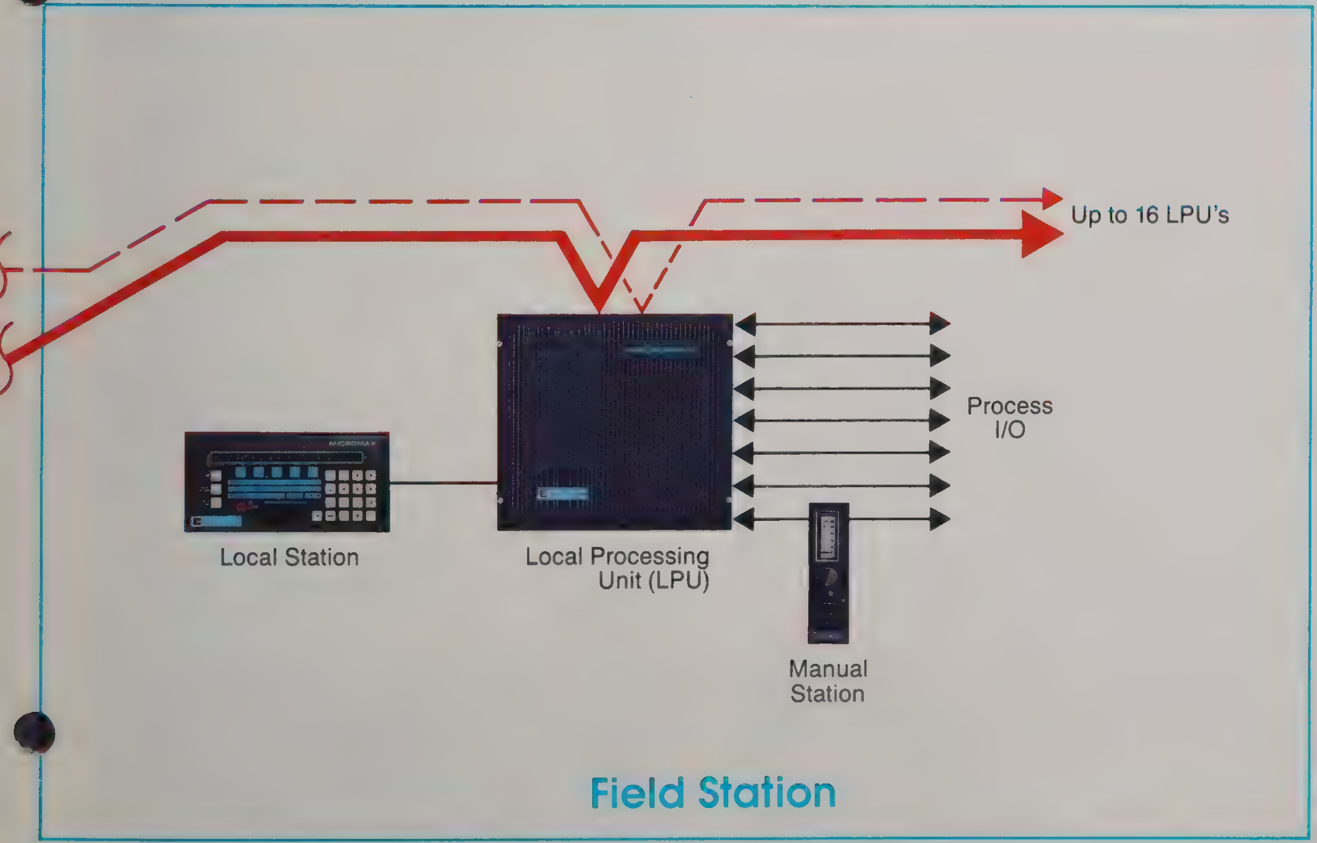
1) a powerful data acquisition system, or
2) a totally integrated process management system including data acquisition, loop control and logic control.

The centrally located Management Station is used to configure the data acquisition and/or control scheme for a process, as well as to provide a man/machine interface for monitoring and supervising operations. It communicates with Local Processing Units over a multi-drop serial data link, collecting information which can be displayed on its CRT screen in a variety of formats or printed out if desired. A long-term and short-term data storage and retrieval capability permits in-depth analysis.

The Field Station is physically separate from the Management Station and can be located at the process up to 2500 ft. away. Here, the Local Processing Unit (LPU) operates completely independent of the Management Station once it has been configured. The measurement of analog variables and discrete events, which are the inputs to the LPU, become part of the MICROMAX database. These measurements are directed to computational algorithms to create intermediate values, labeled "pseudo points." Any input value, user-entered constant, or pseudo point can be soft-wired to interact with any of the loop, logic or data acquisition algorithms. Examples of the inputs, functions and algorithms available in an LPU include PID Control, Cascade Control, Ratio, Setpoint Programmer, Drum Sequencer, Ladder Logic, Optimization, Averaging, Totalization, etc. Working together, they form a firmware package that can be adapted to exactly fit the requirements of the process. And the physical distribution of the hardware keeps the installed cost down and system reliability high.

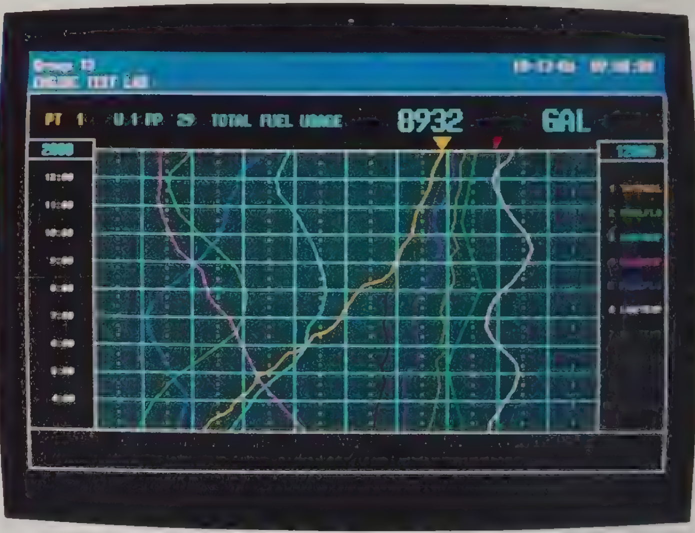
Look into it

Here are some reasons why you should consider using the MICROMAX Process Management System to manage a process you're about to install or to modernize an existing process . . .



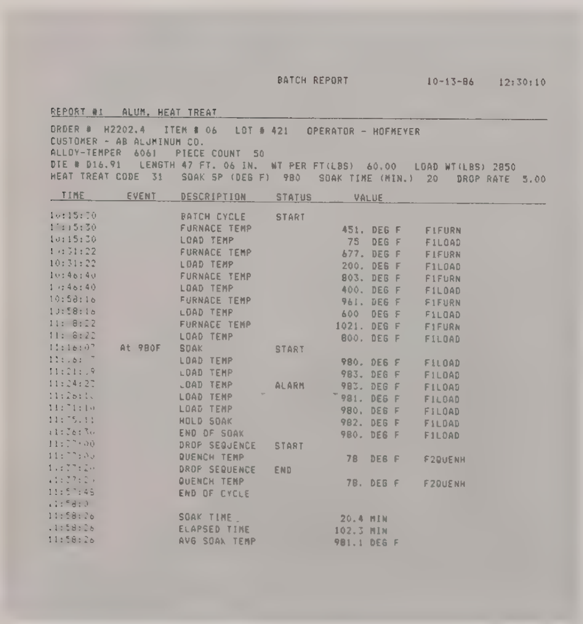
Cost effective for data acquisition and/or control.

When data acquisition is the only requirement, a MICROMAX Process Management System is competitive with strip chart recorders tracking as few as 75 points, and costs little more than ordinary data loggers. But there's really no comparison when it comes to what's provided. For example, the display is a 16-color CRT for showing a variety of graphic presentations (including several strip chart formats). Management reports can be displayed in either standard or user-configured formats. An extensive library of algorithms for computations and calculations are provided, including averaging, group averaging, math functions, etc. Inputs of different types—millivolts, volts, milliamps, discrete signals—representing process measurements—temperatures, pressures, flows—are directly accepted. All points or calculated values can be scanned for alarms. Data can be archived in real-time or data compression storage modes. The added value received from a MICROMAX makes it far more cost effective for data acquisition than any competitive approach.



Process data can be presented as a tabular list, a vertical bar graph, a horizontal trend or a vertical trend as shown

When used to automate one or more unit processes, either batch or continuous, MICROMAX can be sized to efficiently handle as few as 2 control loops having just 15 digital inputs and outputs and 15 data points. Or it can embrace up to 64 loops where more than 1000 analog inputs and outputs and over 2000 digital inputs and outputs must be accessed. And again, offering all the advantages associated with MICROMAX, so that it does a great job for a relatively small investment.



```
                                   BATCH REPORT            10-13-86    12:30:10

REPORT #1   ALUM. HEAT TREAT
ORDER #  H2202.4   ITEM # 06   LOT # 421   OPERATOR - HOFMEYER
CUSTOMER - AB ALUMINUM CO.
ALLOY-TEMPER  6061   PIECE COUNT  50
DIE # D16.91   LENGTH 47 FT. 06 IN.  WT PER FT(LBS)  60.00   LOAD WT(LBS) 2850
HEAT TREAT CODE  31   SOAK SP (DEG F)  980   SOAK TIME (MIN.)  20   DROP RATE  5.00
  TIME       EVENT    DESCRIPTION     STATUS       VALUE

10:15:30              BATCH CYCLE     START
10:15:30              FURNACE TEMP                451. DEG F    F1FURN
10:15:30              LOAD TEMP                    75  DEG F    F1LOAD
10:31:22              FURNACE TEMP                677. DEG F    F1FURN
10:31:22              LOAD TEMP                   200. DEG F    F1LOAD
10:46:40              FURNACE TEMP                803. DEG F    F1FURN
10:46:40              LOAD TEMP                   400. DEG F    F1LOAD
10:58:16              FURNACE TEMP                961. DEG F    F1FURN
10:58:16              LOAD TEMP                   600  DEG F    F1LOAD
11: 8:22              FURNACE TEMP               1021. DEG F    F1FURN
11: 8:22              LOAD TEMP                   800. DEG F    F1LOAD
11:16:07    At 980F   SOAK            START
11:16:[illegible]     LOAD TEMP                   980. DEG F    F1LOAD
11:21:[illegible]9    LOAD TEMP                   983. DEG F    F1LOAD
11:24:2[illegible]    LOAD TEMP       ALARM       983. DEG F    F1LOAD
11:26:1[illegible]    LOAD TEMP                   981. DEG F    F1LOAD
11:31:10              LOAD TEMP                   980. DEG F    F1LOAD
11:35.11              HOLD SOAK                   982. DEG F    F1LOAD
11:36:30              END OF SOAK                 980. DEG F    F1LOAD
11:37:00              DROP SEQUENCE   START
11:37:00              QUENCH TEMP                  78  DEG F    F2QUENH
11:37:20              DROP SEQUENCE   END
11:37:2[illegible]    QUENCH TEMP                  78. DEG F    F2QUENH
11:57:45              END OF CYCLE
11:58:0

11:58:26              SOAK TIME                  20.4 MIN
11:58:26              ELAPSED TIME              102.3 MIN
11:58:26              AVG SOAK TEMP             981.1 DEG F
```

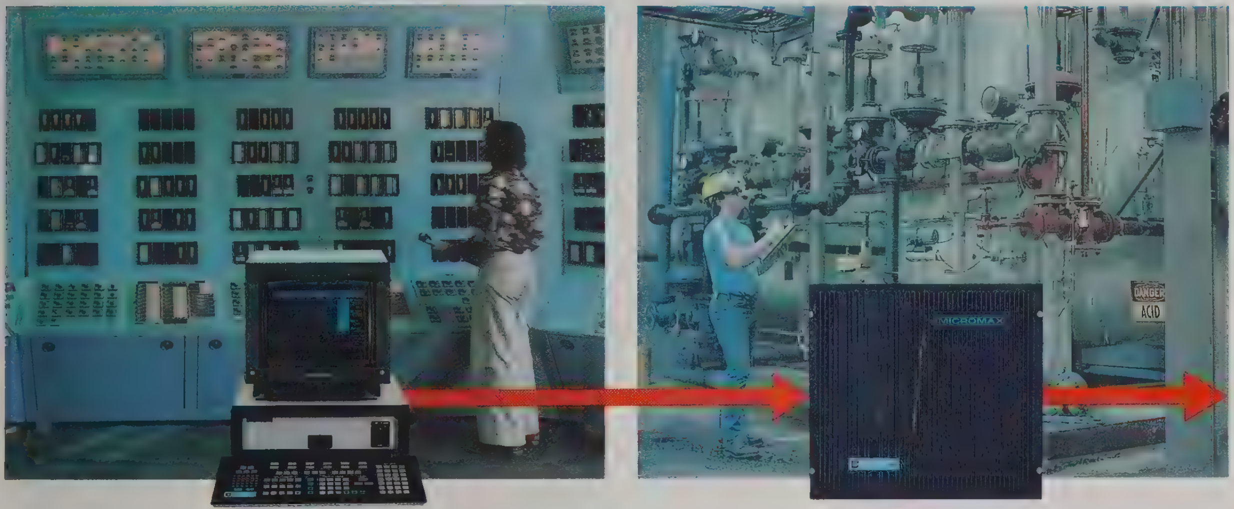
A batch report can be configured which logs selected events during a batch cycle and analog data at specific time intervals

Meets all process requirements, either batch or continuous.

A MICROMAX Process Management System embraces all the operations necessary to regulate a process and provide meaningful data. When applied to a batch process, it can be used to create a batch recipe and store the recipe on a module. With this module the recipe can be loaded at either the Management Station or at the Local Station. The process can be monitored on-line, and in the event of process upset, the operator can intervene through the Local Station or Management Station to correct the situation.

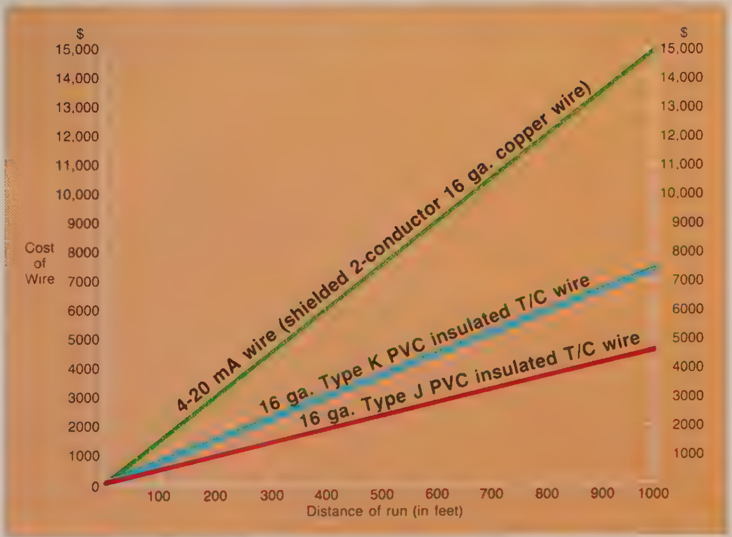
Full documentation is provided through a display and a printout of a batch report (or batch ticket) showing control parameters and time sequences. This batch ticket can be furnished either in a standard format or in one configured by the user, listing the type of material, the heat treating code, the customer's name, etc. All required operations in the preparation of this report are carried out without any expense for additional equipment.

Physically distributed hardware saves money while improving reliability.



The physical separation of the MICROMAX Management Station from the independently operational Field Stations significantly reduces installed wiring costs when compared to control equipment which is centrally located. Just the cost saving in wire alone is considerable (see chart). With MICROMAX, all measurement and control hardware is field-mounted right at the process. A single 5-wire data transmission cable connects the Local Processing Unit to the Management Station which may be located up to 2500 ft. away. There's no need for signal conditioning through transmitters.

And since the signals for the control loops don't have to travel over long distances, they are less susceptible to degradation by electrical noise as well as less vulnerable to damage. This heightened reliability coupled with the minimal wiring costs further enhances the cost effectiveness of the MICROMAX approach.



Typical Wiring Costs for 15 Points*

* does not include the cost of conduit or cable, the labor costs for installation, or the cost of any intermediate terminations which may be required

Custom control without a custom price.

By using various equipment arrangements in the Management Station and Field Station, and dovetailing input and output assignments with specific process requirements, a hardware and software package can be sized to completely manage a process in the most efficient manner possible. But it's done without any special engineering and without any sophisticated programming. The consolidation of all process management functions in a single package, the multiple combinations of digital and analog inputs and outputs, the soft-wired circuitry that makes possible an almost unlimited number of control configurations, all contribute to making MICROMAX a superior alternative to a custom system. You get a control configuration exactly sized to your process at an "off the shelf" price.

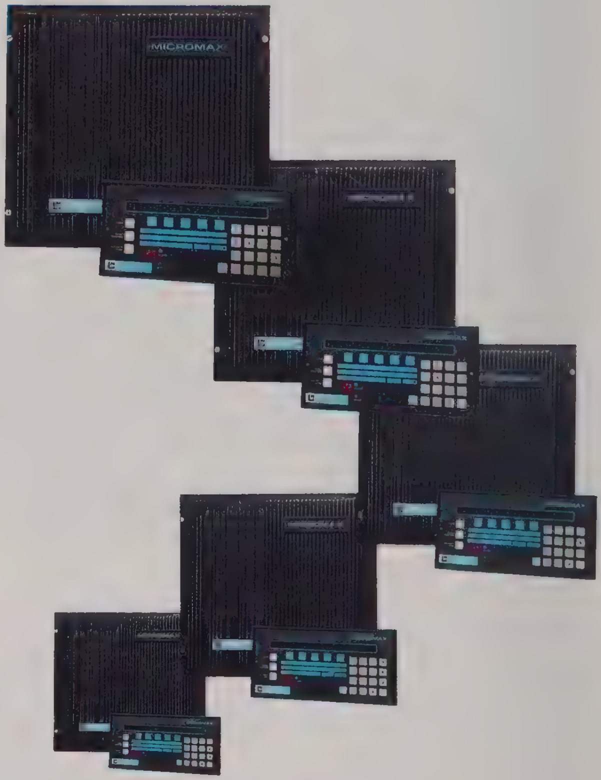
Grows as your needs grow.

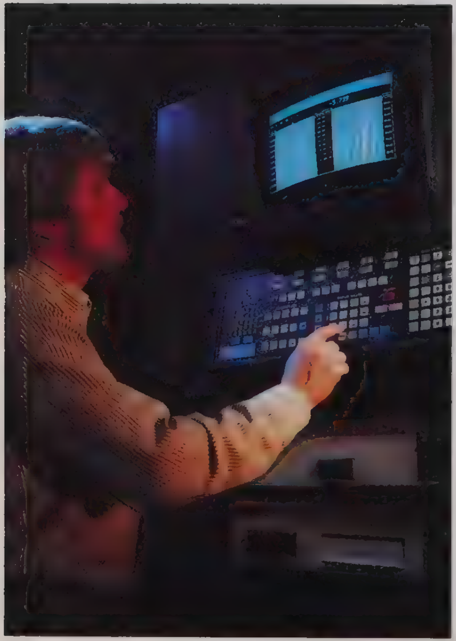
Each MICROMAX Process Management System can be expanded to incorporate as many as 16 Field Stations, so it can be readily extended to new process units as they come on line. And since all 16 LPU's can be configured and monitored from the original Management Station, the savings to be realized from this shared overhead arrangement can be considerable.

If additional monitoring capability is desired, one or two Local Stations can be located at the process for each LPU, Supervisory Stations can be linked to the LPU's offering redundancy to the Management Station if desired, or a PC may be linked to the LPU's using a DATAVUE™ reporting and graphics software package. A Supervisory Station can be dedicated to specific LPU's or handle a separate management task, such as providing trend displays. Supervisory Stations have access to all current systems data and, like the Management Station, can be used to change setpoints, select and load recipes, and assume manual control. There is one exception—they can't be used to configure the Local Processing Units.

If the workload becomes too great for a single printer, a second printer can be added to the Process Management System to share printout assignments. For instance, one printer could take care of all report logging while the second printer would be dedicated exclusively to alarm logging.

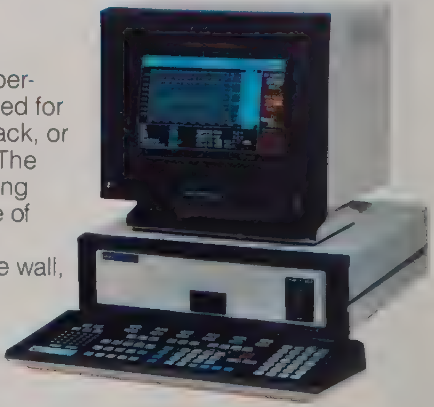
These inherent capabilities, which also include serial data links to accommodate a process or personal computer or other L&N equipment, afford the user assurance that future expansion of a MICROMAX installation to encompass additional unit processes will be done quickly, simply and economically.





MICROMAX Management Station is available for mounting several ways; self-contained LPU mounts near process.

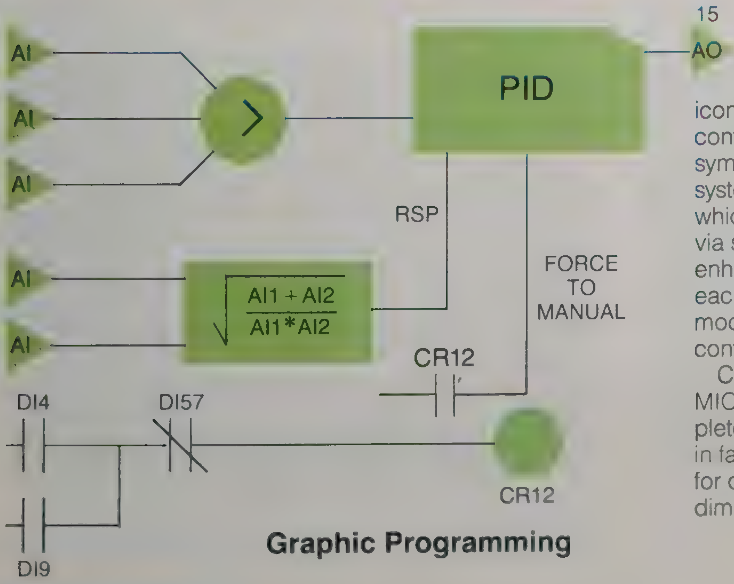
The modular MICROMAX Management Station or Supervisory Station can be supplied for mounting on a panel, in a rack, or in a tabletop arrangement. The MICROMAX Local Processing Unit is a free-standing piece of hardware housed in its own NEMA 4 cabinet that can be wall, rack, or panel mounted.



Built to work on the factory floor.

Since the Local Processing Unit is the core of the system and designed to be located at the process, it is housed in a rugged, watertight and dust-tight NEMA 4 case and built to operate over a temperature range of –10°C to 55°C (14°F to 131°F). Behind its bolt-on cover is a removable card cage allowing ready access to heavy-duty terminal boards which directly accept field wiring of up to 14-gage wire. Thermocouples and RTD's are also directly accepted without any intervening signal conditioning. For speed and ease in servicing, all printed circuit cards can be removed from the rear of the swing-out chassis without removing the input connections.

MICROMAX soft-wired technology vs. hard-wired method is no contest.



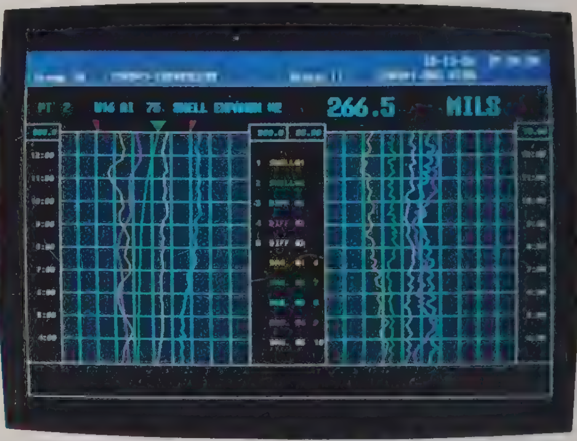
Graphic Programming

MICROMAX enables soft-wired control configurations to be created quickly and simply at the Management Station using various icons on the CRT display screen. A dynamic graphic configuration diagram enables an operator to enter symbols and shift them around to build a control system which will envelop all the variables and events which are part of the process. This technique of wiring via software results in a control configuration which enhances productivity because it's exactly fitted to each particular operation. And if the process changes, modifications can be made just as easily as the initial configuration.

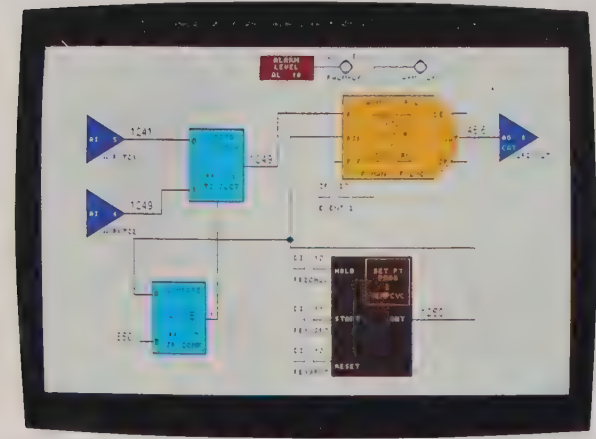
Compared to hard-wired installations, the soft-wired MICROMAX Field Station (which operates with complete independence once configured) can be installed in far less time—at a much lower cost. And the flexibility for quick reconfiguration whenever it's required adds a dimension not available in any hard-wired installation.

A variety of screen displays and printouts give you a good look at the process.

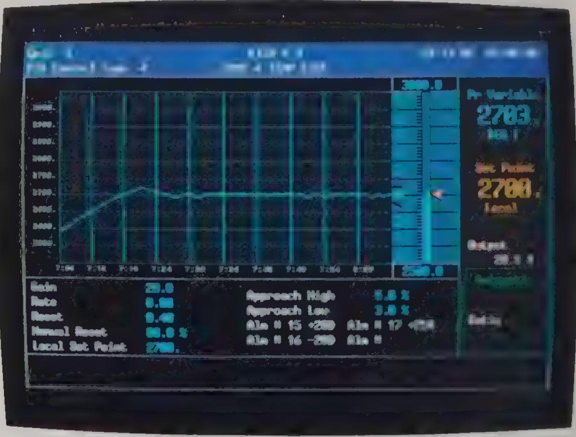
You get a closer, clearer view of process dynamics through the windows of numerous screen displays. Pictured are a number of the screens available for information management and supervisory control.



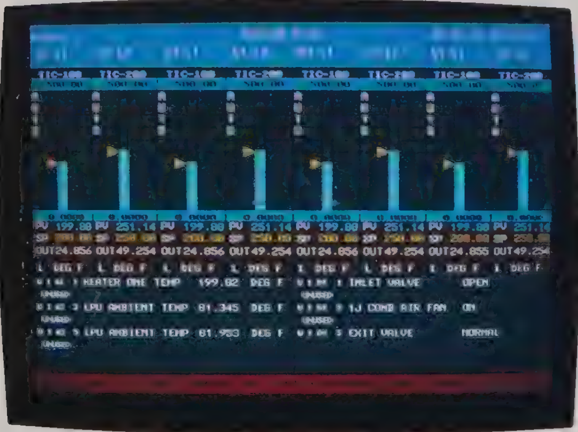
A vertical trend format emulates a strip chart recorder with a single scale, a dual scale (shown) or a triple scale to aid in grouping related point data.


ALARM LEVEL
HOLD
START
RESET

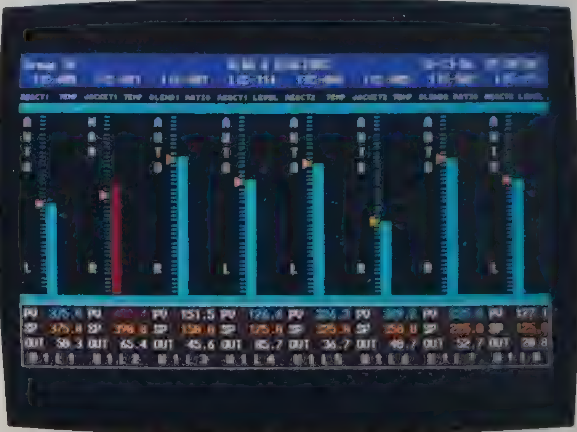
Set-up screens are available where function block icons can be positioned graphically and soft-wired to configure new control schemes or modify existing ones quickly and simply.


2703.
Set Point
2700.
Local
Gain
Rate
Reset
Manual Reset
Local Set Point
Approach High
Approach Low

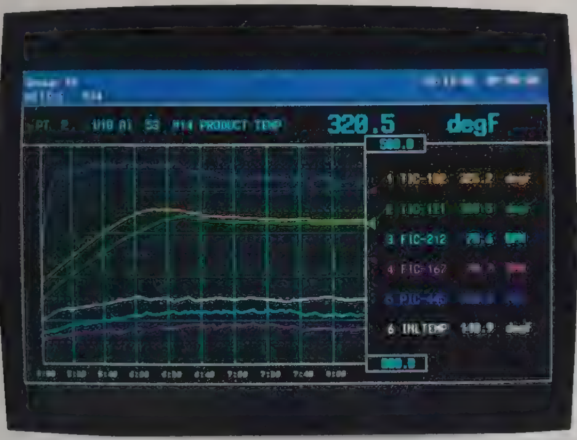
A single loop of control is directly supervised through trending of the controlled variable. When called for, the setpoint can be adjusted, a manual override introduced, or a ratio value altered (where ratio control has been selected)


TIC-100
TIC-200
HEATER ONE TEMP 199.82 DEG F
INLET VALVE OPEN
LPU AMBIENT TEMP 81.345 DEG F
1J COMB AIR FAN ON
LPU AMBIENT TEMP 81.953 DEG F
EXIT VALVE NORMAL

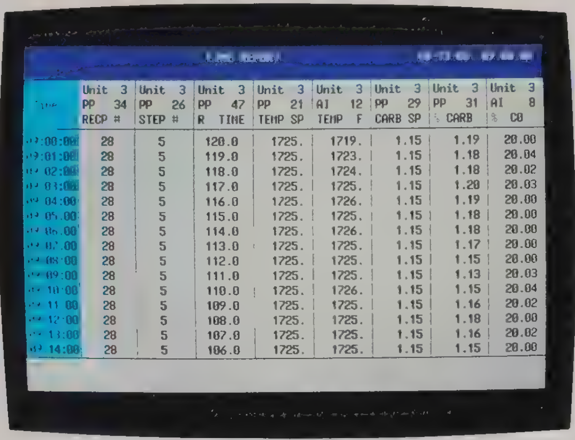
A bar/status display provides an overview of process operations from which control loop parameters can be changed, plus related analog/discrete status indicated.



A bar graph display enables the operator to view the status of a defined group of control loops, and change setpoints and other control parameters

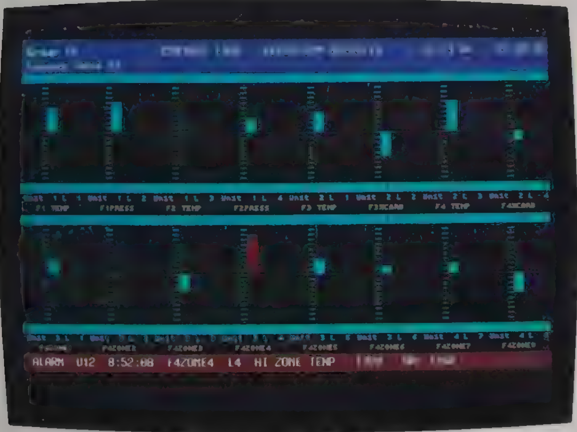

PT. 2 U10 AI 53 #14 PRODUCT TEMP
320.5
degF
3 FIC-212
4 FIC-167
6 INLTEMP

Up to 6 points can be trendea in a horizontal format .



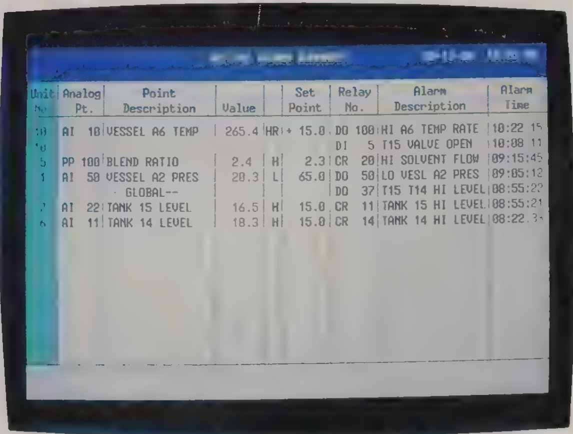
Time	Unit 3 PP 34 RECP #	Unit 3 PP 26 STEP #	Unit 3 PP 47 R TIME	Unit 3 PP 21 TEMP SP	Unit 3 AI 12 TEMP F	Unit 3 PP 29 CARB SP	Unit 3 PP 31 % CARB	Unit 3 AI 8 % CO
00:00	28	5	120.0	1725.	1719.	1.15	1.19	20.00
01:00	28	5	119.0	1725.	1723.	1.15	1.18	20.04
02:00	28	5	118.0	1725.	1724.	1.15	1.18	20.02
03:00	28	5	117.0	1725.	1725.	1.15	1.20	20.03
04:00	28	5	116.0	1725.	1726.	1.15	1.19	20.00
05:00	28	5	115.0	1725.	1725.	1.15	1.18	20.00
06:00	28	5	114.0	1725.	1726.	1.15	1.18	20.00
07:00	28	5	113.0	1725.	1725.	1.15	1.17	20.00
08:00	28	5	112.0	1725.	1725.	1.15	1.15	20.00
09:00	28	5	111.0	1725.	1725.	1.15	1.13	20.03
10:00	28	5	110.0	1725.	1726.	1.15	1.15	20.04
11:00	28	5	109.0	1725.	1725.	1.15	1.16	20.02
12:00	28	5	108.0	1725.	1725.	1.15	1.18	20.00
13:00	28	5	107.0	1725.	1725.	1.15	1.16	20.02
14:00	28	5	106.0	1725.	1725.	1.15	1.15	20.00

Line reports of up to 24 parameters logged at specified intervals can be displayed 8 columns at a time—you tab across the screen to view all 24 columns.


F1 TEMP
F1PRESS
F2 TEMP
F2PASSS
F3 TEMP
F3%CARB
F4 TEMP
F4%CARB
F4ZONE1
F4ZONE2
F4ZONE3
F4ZONE4
F4ZONE5
F4ZONE6
F4ZONE7
F4ZONE8

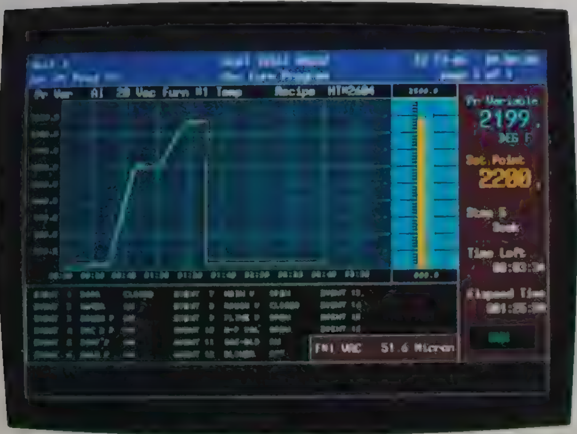
ALARM U12 8:52:08 F4ZONE4 L4 HI ZONE TEMP

All alarms—whether global or from individual Local Processing Units—are reported via a flashing red stripe which will appear at the bottom of any display screen.

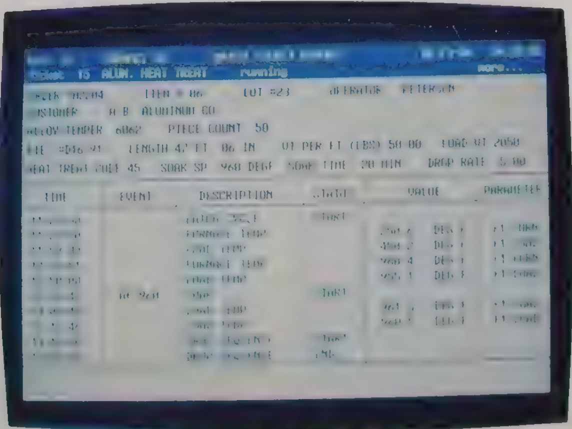


Unit No	Analog Pt.	Point Description	Value		Set Point	Relay No.	Alarm Description	Alarm Time
[illegible]	AI 10	VESSEL A6 TEMP	265.4	HR	+ 15.0	DO 100	HI A6 TEMP RATE	10:22 15
[illegible]						DI 5	T15 VALVE OPEN	10:08 11
5	PP 100	BLEND RATIO	2.4	H	2.3	CR 20	HI SOLVENT FLOW	09:15:45
1	AI 50	VESSEL A2 PRES	20.3	L	65.0	DO 50	LO VESL A2 PRES	09:05:12
		· GLOBAL--				DO 37	T15 T14 HI LEVEL	08:55:22
7	AI 22	TANK 15 LEVEL	16.5	H	15.0	CR 11	TANK 15 HI LEVEL	08:55:21
6	AI 11	TANK 14 LEVEL	18.3	H	15.0	CR 14	TANK 14 HI LEVEL	08:22.3

Both an active alarm summary (shown) and a historical alarm summary are available to display in a consolidated format parameters currently in alarm or previously alarmed


Pr Var AI 20 Vac Furn #1 Temp Recipe HT#2604
Pr Variable
2199.
DEG F
Set Point
2200.
Step 5
Soak
Time Left
Elapsed Time
FN1 VAC 51.6 Micron

On a setpoint program screen the actual process variable is plotted and displayed with the projected setpoint program for ready comparison.



15 ALUM. HEAT TREAT running more...

ITEM # 06 LOT #23 OPERATOR PETERSON

A B ALUMINUM CO

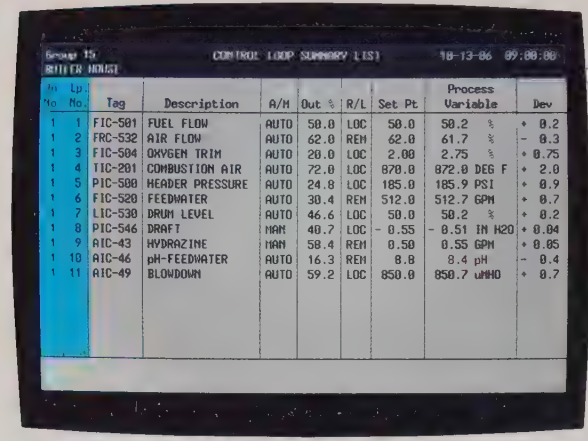
PIECE COUNT 50

LENGTH 42 FT 06 IN WT PER FT (LBS) 50.00 LOAD WT 2050

HEAT TREAT CODE 45 SOAK SP 960 DEGF SOAK TIME 20 MIN DROP RATE 5.00

TIME EVENT DESCRIPTION STATE VALUE PARAMETER

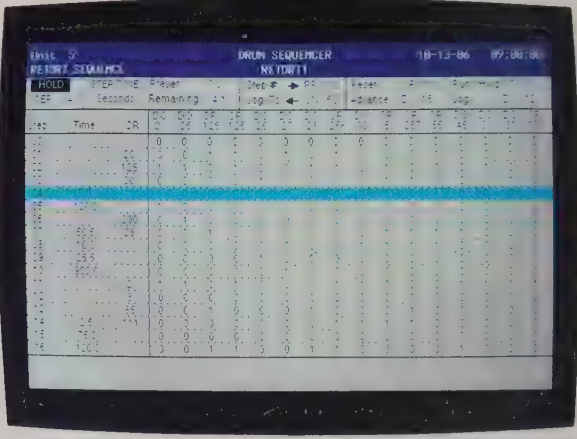
A display of a batch ticket report includes an area for user defined batch information to identify sequentially recorded process variables and events



Group 15 CONTROL LOOP SUMMARY LIST 10-13-86 09:00:00
BOILER HOUSE

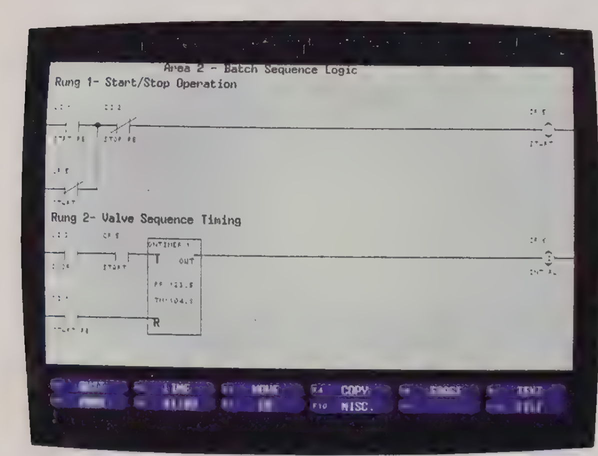
In No	Lp. No.	Tag	Description	A/M	Out %	R/L	Set Pt	Process Variable	Dev
1	1	FIC-501	FUEL FLOW	AUTO	50.0	LOC	50.0	50.2 %	+ 0.2
1	2	FRC-532	AIR FLOW	AUTO	62.0	REM	62.0	61.7 %	- 0.3
1	3	FIC-504	OXYGEN TRIM	AUTO	20.0	LOC	2.00	2.75 %	+ 0.75
1	4	TIC-201	COMBUSTION AIR	AUTO	72.0	LOC	870.0	872.0 DEG F	+ 2.0
1	5	PIC-500	HEADER PRESSURE	AUTO	24.8	LOC	185.0	185.9 PSI	+ 0.9
1	6	FIC-520	FEEDWATER	AUTO	30.4	REM	512.0	512.7 GPM	+ 0.7
1	7	LIC-530	DRUM LEVEL	AUTO	46.6	LOC	50.0	50.2 %	+ 0.2
1	8	PIC-546	DRAFT	MAN	40.7	LOC	- 0.55	- 0.51 IN H20	+ 0.04
1	9	AIC-43	HYDRAZINE	MAN	58.4	REM	0.50	0.55 GPM	+ 0.05
1	10	AIC-46	pH-FEEDWATER	AUTO	16.3	REM	8.8	8.4 pH	- 0.4
1	11	AIC-49	BLOWDOWN	AUTO	59.2	LOC	850.0	850.7 uMHO	+ 0.7

A control loop summary shows the status of up to 16 loops, and allows the operator to select auto/manual or remote/local and alter manual output and local setpoint.



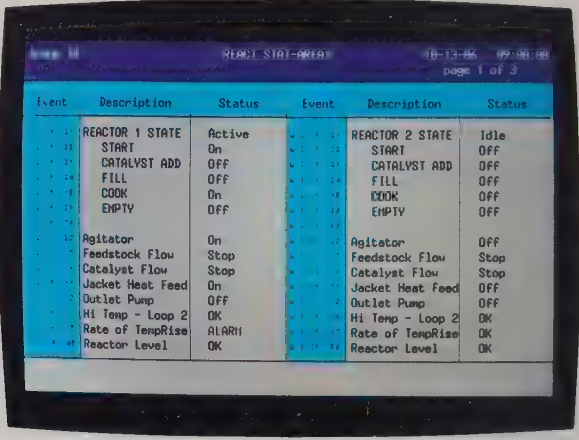
Unit 5 DRUM SEQUENCER 10-13-86 09:00:00
RETORT SEQUENCE RETORT1

A drum sequencer function used to reduce the amount of logic programming for sequential operations is monitored on its own display screen.



Area 2 - Batch Sequence Logic
Rung 1- Start/Stop Operation
Rung 2- Valve Sequence Timing
T
OUT
R
COPY
MISC.

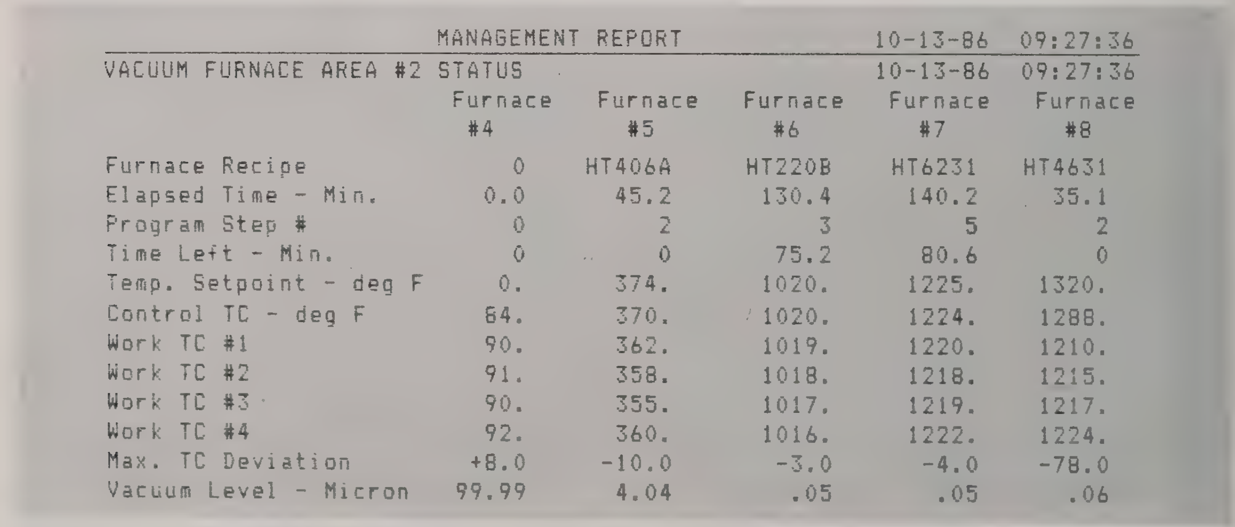
Ladder diagram displays indicating the power flow permit graphic programming of logic.



REACT STAT-AREA1 10-13-86 09:00:00
page 1 of 3

Description	Status	Description	Status
REACTOR 1 STATE	Active	REACTOR 2 STATE	Idle
START	On	START	Off
CATALYST ADD	Off	CATALYST ADD	Off
FILL	Off	FILL	Off
COOK	On	COOK	Off
EMPTY	Off	EMPTY	Off
Agitator	On	Agitator	Off
Feedstock Flow	Stop	Feedstock Flow	Stop
Catalyst Flow	Stop	Catalyst Flow	Stop
Jacket Heat Feed	On	Jacket Heat Feed	Off
Outlet Pump	Off	Outlet Pump	Off
Hi Temp - Loop 2	OK	Hi Temp - Loop 2	OK
Rate of TempRise	ALARM	Rate of TempRise	OK
Reactor Level	OK	Reactor Level	OK

A logic table display shows the status of major events in a batch process.

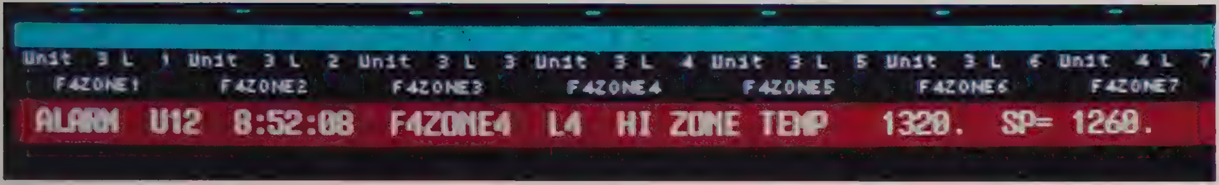


```
                              MANAGEMENT REPORT                10-13-86   09:27:36
VACUUM FURNACE AREA #2 STATUS                                  10-13-86   09:27:36
                             Furnace   Furnace   Furnace   Furnace   Furnace
                               #4        #5        #6        #7        #8

Furnace Recipe                   0     HT406A    HT220B    HT6231    HT4631
Elapsed Time - Min.            0.0       45.2     130.4     140.2      35.1
Program Step #                   0          2         3         5         2
Time Left - Min.                 0          0      75.2      80.6         0
Temp. Setpoint - deg F          0.       374.     1020.     1225.     1320.
Control TC - deg F             64.       370.     1020.     1224.     1288.
Work TC #1                     90.       362.     1019.     1220.     1210.
Work TC #2                     91.       358.     1018.     1218.     1215.
Work TC #3                     90.       355.     1017.     1219.     1217.
Work TC #4                     92.       360.     1016.     1222.     1224.
Max. TC Deviation             +8.0      -10.0      -3.0      -4.0     -78.0
Vacuum Level - Micron        99.99       4.04       .05       .05       .06
```

A free-form management report is configured by the user as to what data is to be entered—useful in providing a custom process overview, a summary of utilization, the status of several operations, etc

Extensive alarm network can be configured to handle all situations.



```
Unit  3 L  1 Unit  3 L  2 Unit  3 L  3 Unit  3 L  4 Unit  3 L  5 Unit  3 L  6 Unit  4 L  7
  F4ZONE1        F4ZONE2        F4ZONE3        F4ZONE4        F4ZONE5        F4ZONE6        F4ZONE7
ALARM  U12  8:52:08  F4ZONE4  L4  HI ZONE TEMP   1320.  SP= 1260.
```

The MICROMAX Management Station provides alarm information of all types, including analog level, deviation, open inputs, discrete, rate of change, or based on calculations. Alarms are time-stamped and directed to relays in the LPU, if desired, then reported to the Management Station which also has a common alarm relay for connection to a horn or other alarm device.

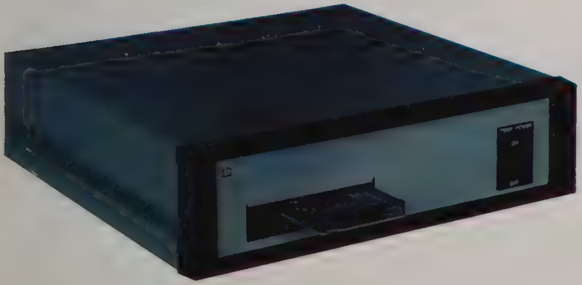
To alert the operator, all alarms are announced with a flashing red stripe which appears at the bottom of any screen currently on display. At the same time they can be routed to a printer for logging. A two-line area is reserved on each screen to permit display of an alarm, reportable event, open input and diagnostic fault).

When an alarm is announced, the operator silences the station horn with an Acknowledge key which also calls up on the screen either a summary of all active alarms or a preselected screen with associated process data. Using this information he can respond quickly to correct off-normal conditions.

The operator can depress an Alarm Summary key at any time to view a listing of all active alarms (up to 150) or the last 50 alarms which have cleared.

With MICROMAX, a comprehensive alarm network can be configured for each application which will assure a continuing high level of security.

Process data can be stored and retrieved at will... in the format of your choice.



Residing within the Management Station is adequate memory storage capacity for handling labels, tags, current trends, limited reports and configuration programs for all Local Processing Units. But an optional Data Storage Unit adds the capability to also store data on a historical basis, to maintain backup copies of configuration programs stored in the Management Station, and to expand the number of recipes available beyond those contained in a recipe module.

Short-term historical information such as trends of data gathered over the past 48 hours (as compared to current trend data), can be stored on a 45-megabyte hard disk. There is also a 60-megabyte removable tape cartridge for the storage of data on a long term basis as archival information or as backup to the hard disk.

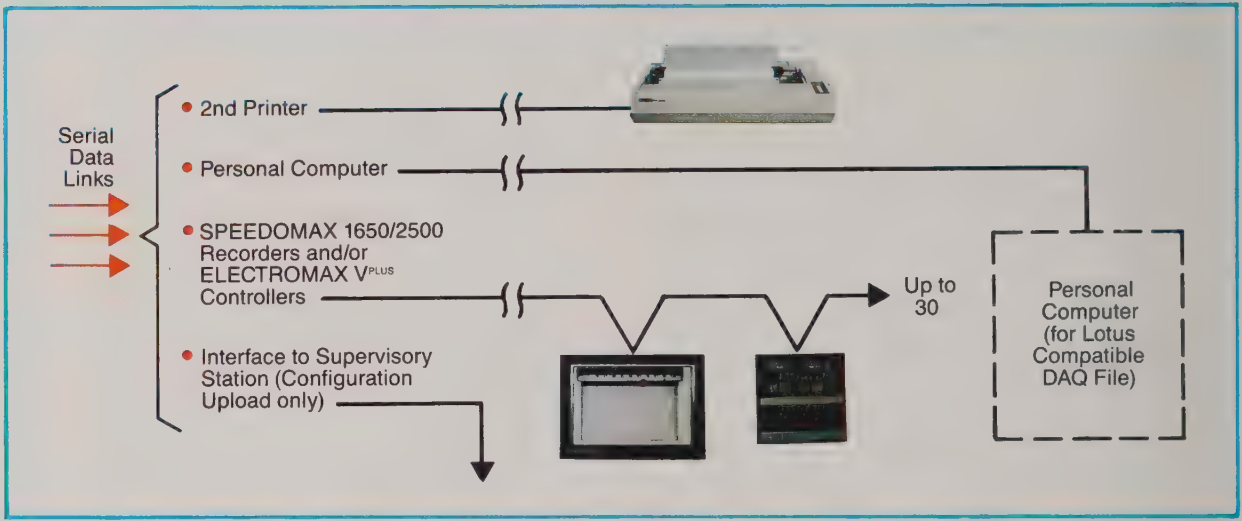
Data can be stored in its entirety or, for greater efficiency, compressed into meaningful samples. Data compression can take the form of periodic samples, averaged values over a specified time period, or high and low readings, enabling you to archive significant quantities of critical process information.

Stored data is readily retrievable from either the disk or tape cartridge for display in a selection of formats. For example, information could be presented as a tabular report, a vertical recorder-like trend, a horizontal trend, a bar chart, a tabular list, a batch report, or a management report.

The Data Storage Unit offers substantial information storage capacity, the ability to store complete or compressed blocks of data, ease of retrieval, and the inherent capability to present retrieved data in a number of formats. It adds an important new dimension to the management of process information.

Completely compatible with existing instrumentation.

Where L&N Speedomax recorders or Electromax V$^{\text{PLUS}}$ single-loop controllers are already in place, or are planned additions, the instruments can be incorporated into the MICROMAX Process Management System via serial communications to a port in the Electronics Unit. As many as 30 instruments located as far away as 1000 ft. can be accommodated on a single data link. One, two, or three low-speed serial ports are available to interface MICROMAX with a personal computer and an additional printer.


Serial Data Links
2nd Printer
Personal Computer
SPEEDOMAX 1650/2500 Recorders and/or ELECTROMAX V$^{\text{PLUS}}$ Controllers
Interface to Supervisory Station (Configuration Upload only)
Up to 30
Personal Computer (for Lotus Compatible DAQ File)

Can be effectively applied to almost any unit process.

We've listed some typical applications which would benefit from the MICROMAX approach. However, these applications simply scratch the surface—opportunities exist in hundreds of unit processes to use the MICROMAX Process Management System effectively.

Process Management

- Furnaces/Ovens/Kilns
- Chemical Reactors
- Boilers
- Glass Manufacturing Operations
- Autoclaves
- Pilot Plants
- Environmental Test Chambers

Data Management

- Turbine/Generator Monitoring
- Temperature Profiling
- Process Monitoring
- Distillation Columns
- Performance Analysis
- Analytical Chemistry

. . . and many more.

More detailed information, including specifications, can be found in the MICROMAX Data Booklet, available from your nearest Leeds & Northrup Sales Representative. Ask for booklet GO.0001-DB. Also, Data Sheet GO.0003-DS describes DATAVUE™ Software for MICROMAX Process Management Systems.

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LEEDS & NORTHRUP SYSTEMS
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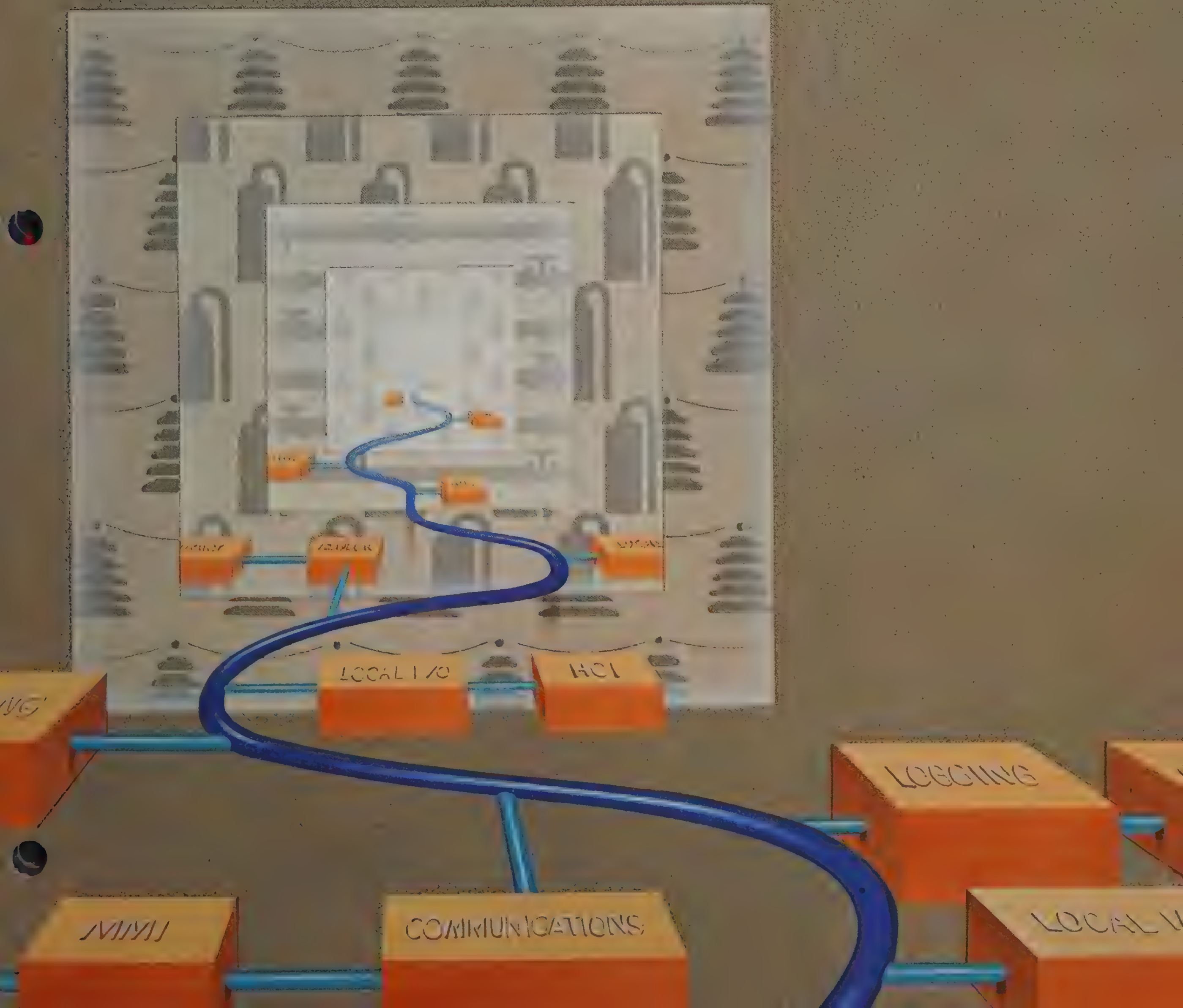
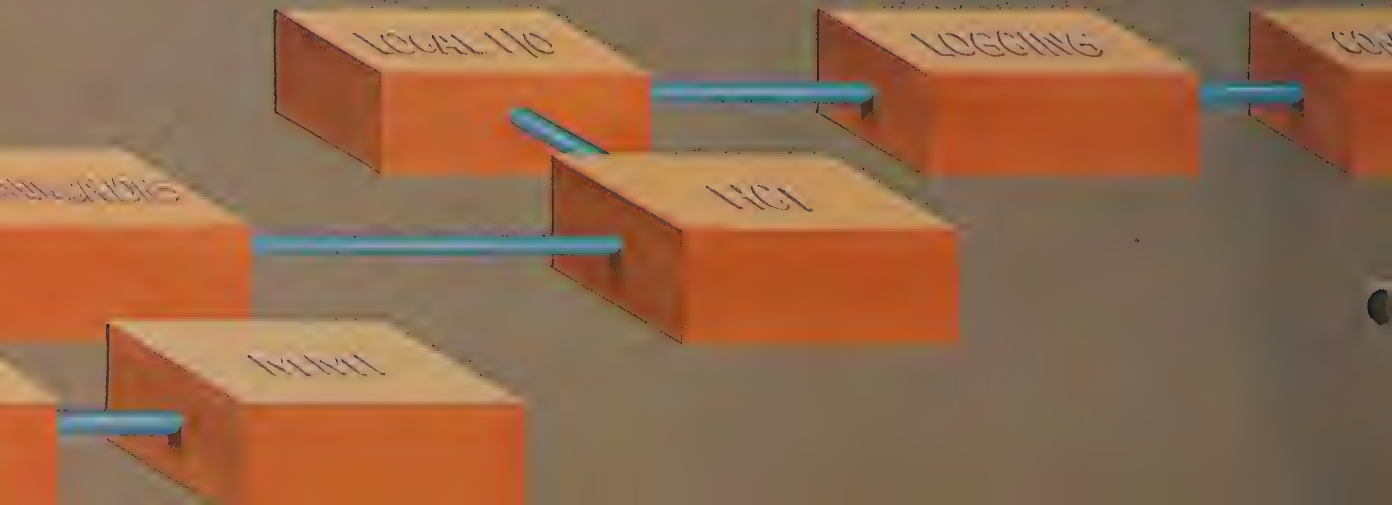
We'll keep you in control with this unique expandable system . . .

LEEDER Series LN700™ Distributed SCADA System

. . . a new cost-effective approach to SCADA using proven distributed systems architecture & on-line configurable software


LOCAL I/O
HCI
LOGGING
MMI
COMMUNICATIONS

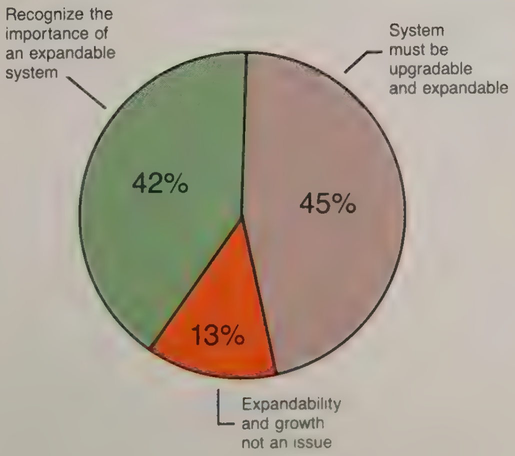

LOCAL I/O
LOGGING
HCI
MMI

Introducing the LEEDER Series LN700 Distributed SCADA System

from Leeds & Northrup, long the leader in control systems for the Power Industry

The new LN700 Distributed SCADA System employs the *proven* distributed systems architecture concept with distributed processing, and a distributed data base to handle a wide range of SCADA system sizes. Each station along a high speed data highway uses a dedicated advanced technology microprocessor, a modern multiprocessing bus, and ample memory to support a fully loaded station. The LN700 provides a simple, modular way to add *computer power* for control functions and application software, such as distribution monitoring, network modeling, and load management.

There is *no need* for a host computer, or back-up computers, any complex failover hardware, or complicated failover software. The LN700 employs common hardware for all stations so that the system is incremental and easily expanded, thus keeping the software simple and flexible. With high speed processors and the human-engineered computer-assisted configuration program, you are assured of *easier* programming, *easier* configuring and *limitless* processing power. System size of the LN700 can range from a small SCADA application where as few as 500 data points are monitored from four to five RTU's up to applications involving 50,000 or more data points at hundreds of remote terminal units. The key to this expansion flexibility is the distributed architecture of the LN700.


Recognize the importance of an expandable system
42%
System must be upgradable and expandable
45%
13%
Expandability and growth not an issue

A recent survey of electric utilities involved in generation, transmission and distribution highlight the importance of system expandability.

Of those utilities responding, 45% demand easy expandability and an upgrade path. An additional 42% recognize the importance and eventual savings of initially installing a SCADA system designed for growth and ease of expansion.

What expansion requirements will you be faced with through the next decade?

Architecture of the LN700 . . . featuring simplicity, reliability and expandability

1. Redundant Data Highways—each highway, a co-axial electric-cable, provides secure station access at one megabit per second via radio frequency modems.

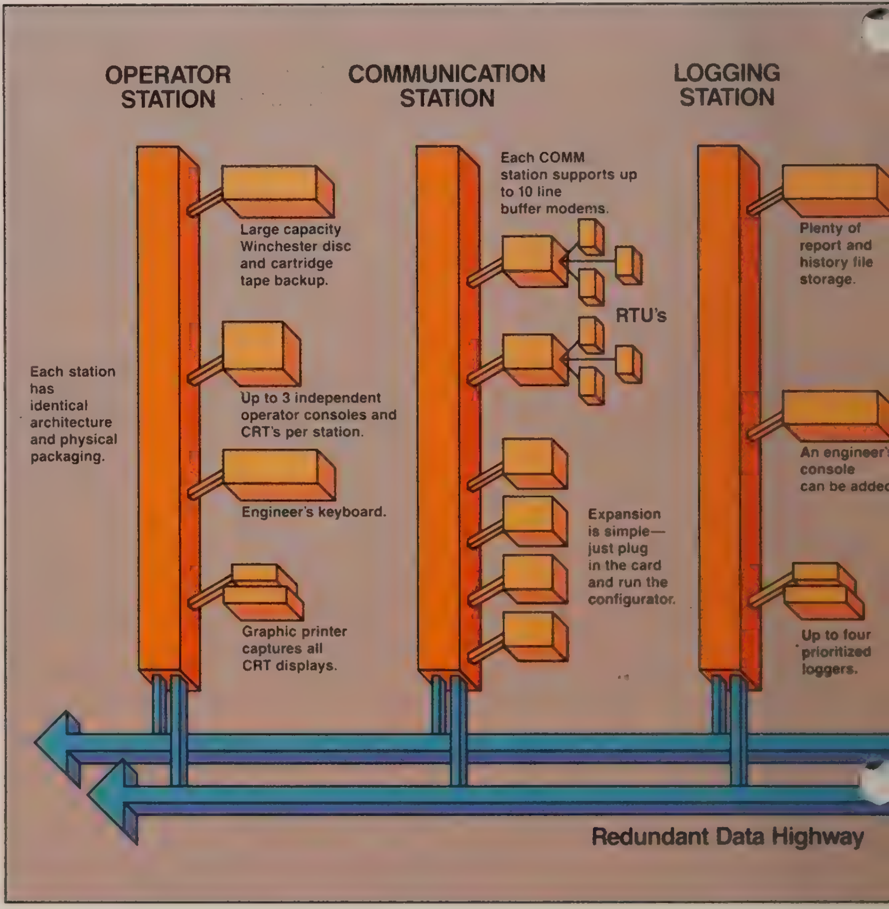
2. Operator Station—interfaces the operator to the system. Each "Op Station" may include up to three Operator Panels and three high-resolution, color CRT screens. An optional Engineer's Keyboard permits picture and data base compilations. The Op Station provides local storage of CRT display formats and has local logging capability. It receives dynamic data from other stations through the data highway.

3. Communications Station—manages all data transmission to and from RTUs, processes the raw data, and maintains the data base for scanned and locally-derived variables. The "Comm Station" also performs status change detection and alarm checking, engineering unit conversions, computations and responds to data requests from other stations on the highway.

4. Logging Station (optional)—provides both short and long term data storage and retrieval. User-customized logging formats and special calculations are fully supported by the logging station. The "Log Station" may also incorporate an Operator Panel and CRT for on-line data base and display modification and creation.

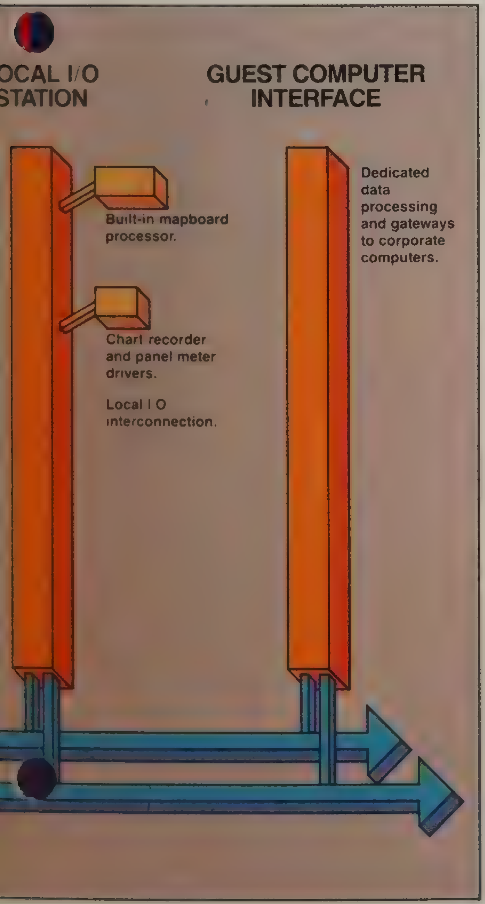
5. Local Input/Output Station (optional)—interfaces local analog and digital inputs and outputs for mapboards or local plant supervision. It also handles analog and BCD displays, alarm sequencing and special calculations. All easily and quickly accomplished with the full-featured configurator program.

6. Guest Computer Interface (optional)—a true host computer is *not* necessary with the LN700 system, but "guest" computers can be easily interfaced for such diverse functions as: data communications network, load management systems, network modeling, maintenance scheduling and other applications.


OPERATOR STATION
COMMUNICATION STATION
LOGGING STATION
Large capacity Winchester disc and cartridge tape backup.
Up to 3 independent operator consoles and CRT's per station.
Engineer's keyboard.
Graphic printer captures all CRT displays.
Each station has identical architecture and physical packaging.
Each COMM station supports up to 10 line buffer modems.
RTU's
Expansion is simple—just plug in the card and run the configurator.
Plenty of report and history file storage.
An engineer'
console
can be adde
Up to four prioritized loggers.
Redundant Data Highway

4 Fundamental Advantages of the LN700 Distributed Architecture

1. Maximum PERFORMANCE
The LN700 performs superbly against all common criteria. For example, *Capacity*—handles up to 50,000 data base points; *Responsiveness*—responds to an operator entry within 0.5 seconds; *System Availability*—not less than 99% . . . The LN700 simply offers more processing power plus a modular way to start with a small system and easily build on it.


OCAL I/O
STATION
GUEST COMPUTER
INTERFACE
Built-in mapboard processor.
Chart recorder and panel meter drivers.
Local I/O interconnection.
Dedicated data processing and gateways to corporate computers.

2. Maximum RELIABILITY
With an LN700 you do *not* need a back up main frame computer. All hardware is distributed on a dual redundant electrical highway, so you are not dependent on a single dominant CPU. Dedicated advanced technology microprocessors in each station perform functionally independent tasks throughout the system.

3. Easy EXPANDABILITY
Start with a small system and because of the inherent subsystem independence of distributed control, additional stations are readily coupled into the data highways. Since a masterless "token passing" technique is used (each station can ask questions, receive answers and bypass non-responsive stations), any new stations are simply connected to the dual highway and they then participate in token passing just as if they had always been there.

4. LOWER initial & life cycle COSTS
Because distributed processing eliminates the need for a central host computer, the LN700 reduces hardware costs *at least 30%*. Very large scale integration (VLSI) circuitry means low input power, lower equipment operating temperature,—which add up to *lower* operating costs and *longer* equipment life.

The LN700 saves you floor space . . .
Historically, dual redundant systems required dedicated computer rooms with raised floors, Halon fire supression systems, large uninterruptable power supply (UPS) systems with battery rooms, and dedicated redundant air conditioning equipment. The LN700 lives with you, requiring a modest *20 square feet* for the master station cabinet and operator desk. A quiet corner of your office with a 120 vac 20 ampere convenience outlet is all that's required.

Many of the circuit cards used within the operator station are identical to those used in the comm station, log station, and local I/O station. The historic dual redundant systems required large inventories of spare parts, dedicated repair and storage rooms staffed by a technical repair team. (The LN700 uses fewer parts, designed to several military and government specifications.)

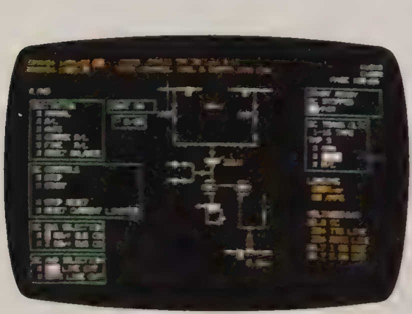
Comfortable, versatile Man/Machine Interface

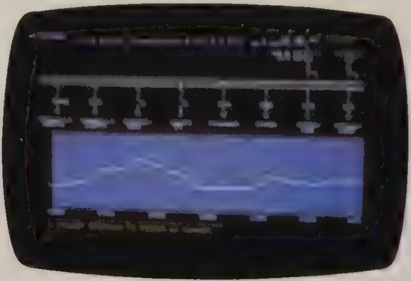
The LN700 employs a very *practical* pushbutton operator panel. The operator's ability to quickly master the system and respond appropriately is achieved by the uncluttered, logically-organized panel. At the touch of a button the operator is presented with specific information allowing rapid and accurate response to a system upset. With one or two button pushes the operator can reclose a substation breaker, or trend an errant line megawatt value to be played back later as part of a post fault analysis.

CRT displays include, for example, electrical one-line diagrams as well as tabular displays. In addition, bar charts and dot resolution trends are provided to highlight system conditions.

The system has the capacity of building, storing, and retrieving literally thousands of CRT tabular and graphic displays with live telemetered and calculated data. The ability to assign any point to any display in the system allows the user to configure the electrical network as a hierarchical generation, transmission, and distribution system. It also provides regional partitioning of the network while providing access to boundary devices such as breakers, transformers, lines, and static switches. Both the transmission dispatcher and distribution dispatcher can view and control boundary devices without being bombarded by data someone else is responsible for.

The Man/Machine Interface of the LN700 gives the user a comfortable, practical method of "seeing the system" on color CRTs. Fully utilized foreground and background colors give instant status of an alarmed point—not just alarm level, but trend—including the ability to achieve panning—or open a window on a substation display to examine a voltage profile.





Sized to meet your need

The LN700 SCADA system ends "Budget-opoly." The distributed architecture of the LN700 system offers you the advantage of purchasing as much or as little master station as you need now. No more "crystal ball" estimates of future requirements . . . No more restrictive system penalty for buying too small a system without growth capabilities . . . No forced financial penalty of purchasing a large system now when a smaller one will meet your short-term needs.

A small LN700 SCADA system consisting of one operator station and one comm station with as few as a hundred data points from five or six RTUs can be easily expanded to a medium or large system retrieving thousands of data points from hundreds of RTUs . . . without any hardware or software expansion penalty!

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A Synopsis of LN700 Highlights

Benefits for Engineering:

☐ *Superior Performance*—with more processing power

☐ *Assured Reliability*—via distributed control with multiple, advanced technology microprocessors and failsoft architecture

☐ *Easy Expandability*—in any direction as needed and easily configured

☐ *Fast Display Building*—using library of shapes

☐ *Automatic Restarting*—plus self-diagnostics

☐ *Flexible Software*—through user-defined calculation routines

☐ *Minimal Installation Costs*—normal office environment

Benefits for Operations

☐ *Consistent Performance*—fast CRT updating under varying system conditions permits prompt operator response

☐ *Easy to Use*—all pushbuttons in the Operator Panel located in logical groups

☐ *Easy to understand Upsets*—prioritized alarms, with most critical alarms first

☐ *Easy to check system Status*—because of regional separation, Operator gets an uncluttered view.

☐ *Easy to Interpret*—snapshots and trends available on Operator command

When you buy a control system from L&N, you get more than the physical product. . . . You receive the TOTAL CORPORATE PRODUCT.

The L&N Corporate Product personifies our customer orientation originated by the company founders in 1899. It is another tangible dimension of Leeds & Northrup embodying the foundation of the instrumentation industry—which translates into confidence, assurance, and satisfaction. At L&N, "The customer is a corporate state of mind."

From the professional sales managers and industry application specialists, searching out and solving your technical problems to the complete after-the-sale customer services, no one supports a customer like L&N.

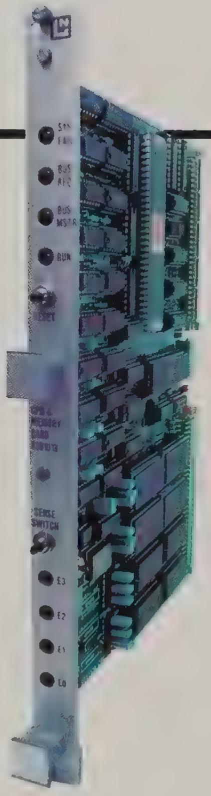
Searching for these qualities?

☐ Application solutions.

☐ A dependable customer support organization that truly cares how your order is handled—dedicated to on-time delivery of a quality product.

☐ A 24 hour toll free help line—worldwide for 48 hour parts replacement.

☐ Comprehensive user training at our location or yours.



☐ A management team committed to product quality and YOUR satisfaction.

When you search for the qualities that transcend the basic product you owe it to yourself to check with L&N on your next project and compare. Your satisfaction, at all levels is our hallmark—and is why so many customers worldwide enjoy their business experience with L&N. We're ready to put you in control. Give us a call today.

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A UNIT OF GENERAL SIGNAL

We put you in control

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TELEPHONE: 215-643-2000 • CABLE ADDRESS "LEEDSNORTH"

COMMUNICATIONS
RTU

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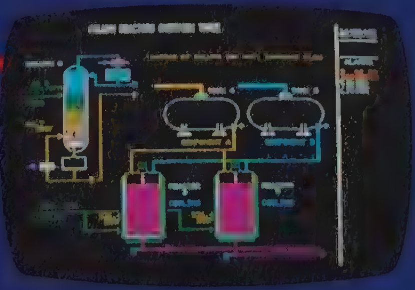
We'll put you in control with this user-proven, powerful system...

MAX 1™ Distributed Control System

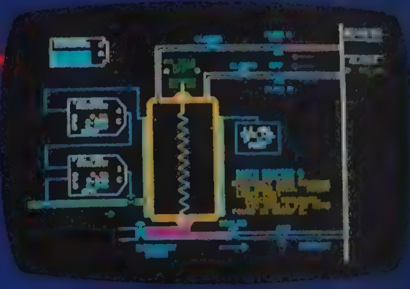
...for processes with as few as 8 control loops, up to centralized control of more than 1600 loops

OUTPUT
+
−
NUMERIC ENTRY
ALARM
SUM'Y
SILENCE
DEFEAT
RSTORE
ACKNOWLEDGE
DISPLAY
LAST
DEFT'D ALARMS
SERIAL DISPLAY TREND
HELP
SINGLE POINT
DISPLAY LIMITS
INST TREND
DETAIL
INPUT
COPY
SELECT
G5
G10
GROUP
S1
S2
S3
S4
S5
S6
S7
S8
S9
S10
S11
S12
S13
S14
S15
S16
7

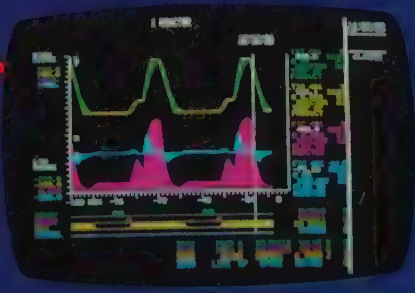
Hundreds of views can describe a process, but this can be very confusing to a user unless there is a reasonable scheme for retrieving the right views at the right time . . . and quickly!



Views must be succinct. This graphic plant overview does not just alarm, but suggests specific corrective action.



The plant engineer is a teammate with the operator, providing data when the unexpected occurs.



Operator and engineer alike can manipulate current as well as archived data, highlighting and amplifying plant actions for better understanding.

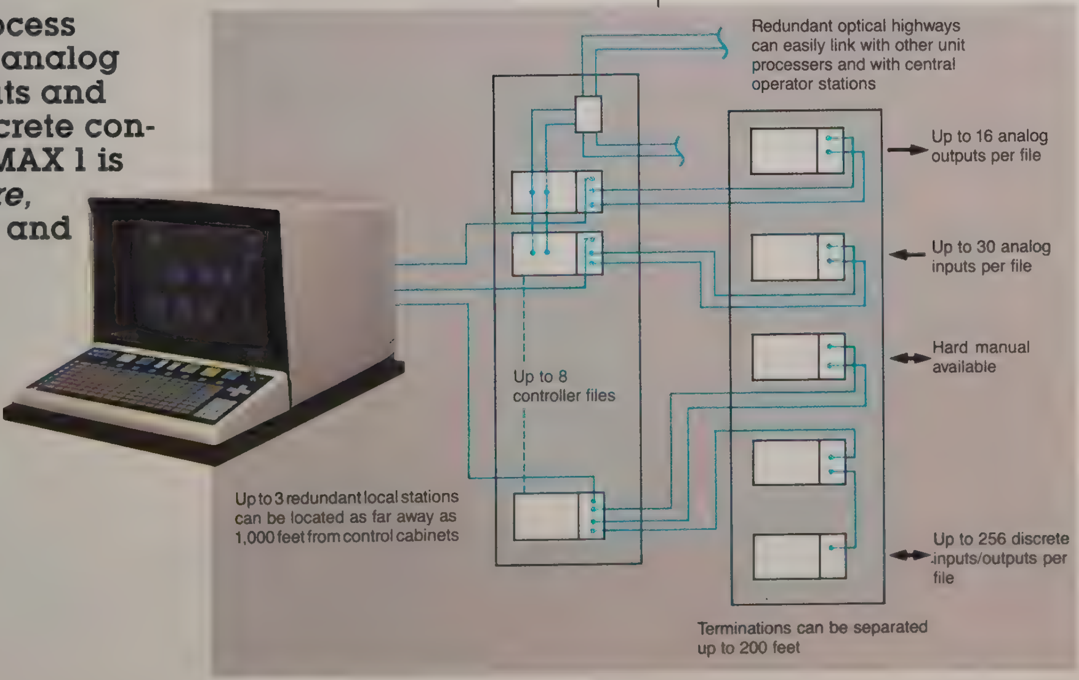
MAX 1™: *Maximum* Control Responsibility plus Reliability

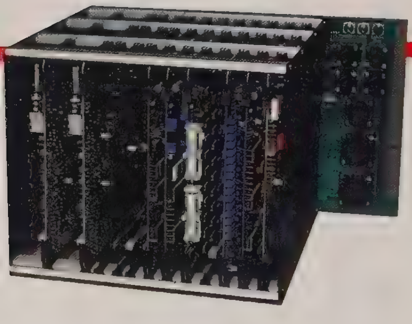
Leeds & Northrup offers simple, reliable solutions for controlling batch or continuous processes

MAX 1™ distributed control systems are already in use in most processing and fabricating industries throughout the world. Introduced in the early '80's, these *user-proven* systems are the outgrowth of L&N's mastery of the science/art of instrumentation. For over 85 years L&N has been a major innovator in measuring, recording and controlling process variables.

Out of years of innovation has emerged the MAX 1 distributed control system. Only a few elements are needed for you to start controlling a simple unit process and easily expand into centralized control. You can rely on the vast experience of Leeds & Northrup—a single-source supplier with complete training, startup and support facilities.

For a unit process with up to 64 analog control outputs and over 1000 discrete control actions, MAX 1 is *simple, secure, cost effective* and *expandable.*


Redundant optical highways can easily link with other unit processers and with central operator stations
Up to 16 analog outputs per file
Up to 30 analog inputs per file
Hard manual available
Up to 8 controller files
Up to 256 discrete inputs/outputs per file
Up to 3 redundant local stations can be located as far away as 1,000 feet from control cabinets
Terminations can be separated up to 200 feet



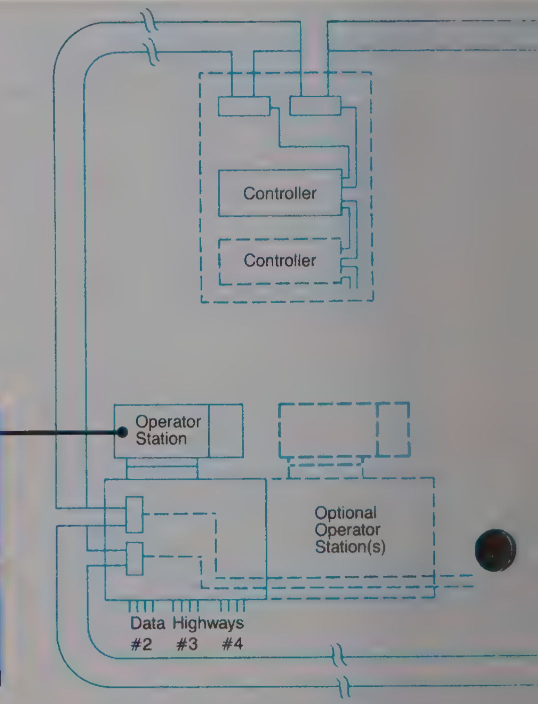
For centralized control of many plant processes, MAX 1 remains simple – needs no computer to drive it, is secure at all levels, at less cost for installation, operation and upkeep.

Microprocessor-based Controller does it all—
consisting of standard, interchangeable PC cards mounted in a cabinet. Each controller file has 32 "time slots" with 30 analog inputs, 256 digital inputs/outputs, and up to 16 analog outputs.

Local Mini-Station, the "process window", requires no special operator skills—
includes a straightforward overview keyboard and an 8-color video screen so that operator can rapidly select, display, monitor and configure commands for as many as 8 controller files. Up to three of these local stations can be used for operating redundancy as well as multiple controlling locations.

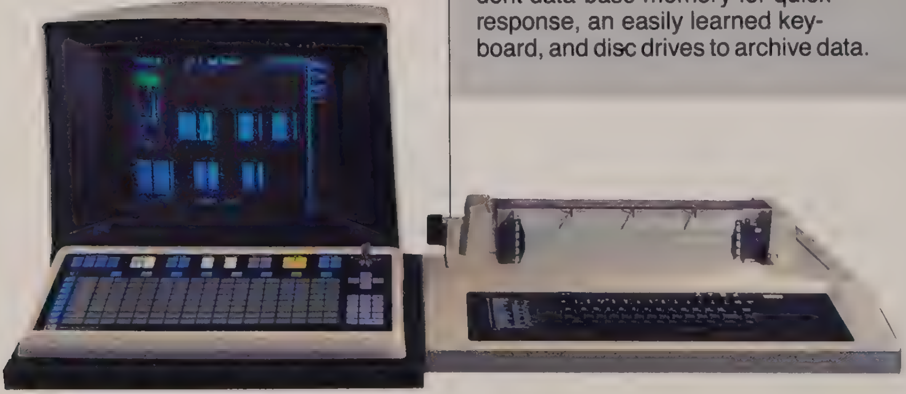
"Record Keepers" easily added—
control configurations can be stored on a tape cartridge . . . outputs on a multi-point Speedomax® recorder … hard copy printouts on a printer … even real time data link to an optional computer or graphics terminal.

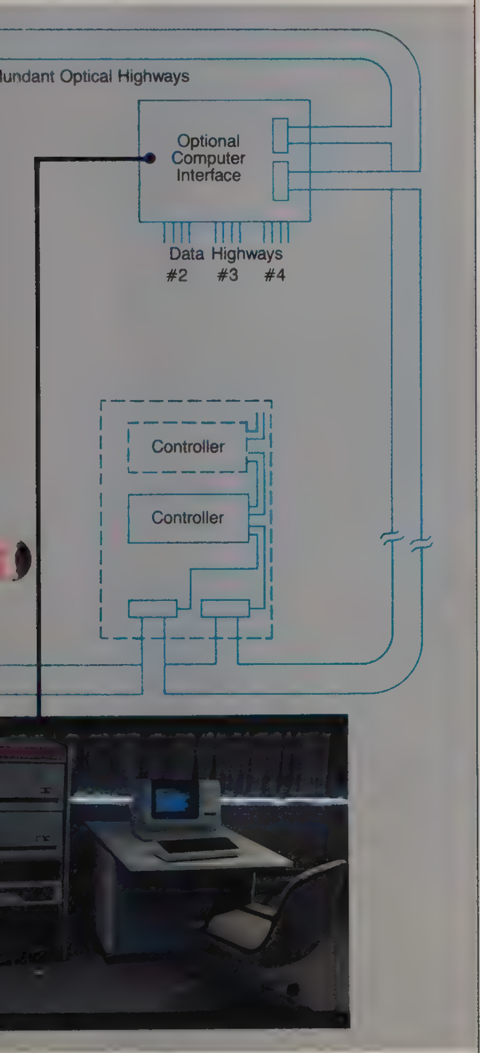
Fiber-Optic Data Highways are immune to electrical and magnetic interference, moisture and chemicals—
proven, state-of-the-art communication cables connect MAX 1 systems, to permit centralized data gathering and master control of more than 1600 loops. MAX 1 always includes redundant highways for maximum security and rapid exchange of data under any conditions.



Operator Stations monitor all—
these local and centralized units give your engineers systems intelligence in several levels of detail, and always only one keystroke away from any corrective action to plant upset. An Operator Station incorporates a crisp 8-color video screen, fully resident data-base memory for quick response, an easily learned keyboard, and disc drives to archive data.

Host Computer not necessary, but "Guest" computers of any type always welcome—
easily interfaced at any point on the optical highways and easily performs rapid exchange of information with any other device on the highway.





Here's what L&N's MAX 1 can do for you:

1. MAXimize Your Process/Plant Performance

MAX 1 makes it possible to achieve optimum performance because engineers and operators have a better view of interactive parameters to make decisions. Thus, it is easier to implement control strategies toward better performance. The following are *actual* performance results obtained by MAX 1 users:

"... will save $118,000 per year because of superior dispatch capability." (utility)

"... higher boiler efficiencies will pay for the system within 2 years." (paper mill)

"... 15% to 17% reduction in fuel costs" (steel mill)

"... heat rate improvement worth $400,000 annually." (utility)

2. MAXimum System Security and Reliability

You are assured of absolute security with L&N's many levels of protection and redundancy. Even with a critical process where loss of costly end product or potentially hazardous conditions are involved, MAX 1 will provide the highest level of security: automatic "hot back-up" in which redundant devices take over without operator assistance or loss of data.

A unique added feature of the data base is the self-correcting memory. In each of three zones on the data base card, a memory chip can fail with absolutely no loss of function or memory. This is not a redundant circuit, but rather an error detecting and correcting scheme that can reconstruct the lost data. And it does not replace the existing capability for automatic dedicated back-up of selected loops or even complete control strategies, in which the data base is regularly monitored. The back-up data base is routinely updated before a failure occurs anywhere in the controller. In a centralized system if one of the optic cables is severed, or even *both*, full communication and timing can still be maintained through intact elements of the two loops . . . that's real redundancy!

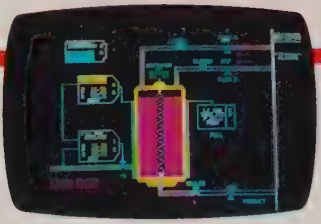
3. Radical Reduction of Installation Costs

Fewer pieces of hardware are needed to create a complete system so installation time is reduced, but the big savings accrue from the use of preassembled cables that interconnect controllers, terminal boards and Mini-Stations. These cables not only eliminate hand wiring, but also provide a positive lock and prevent possible wiring errors.

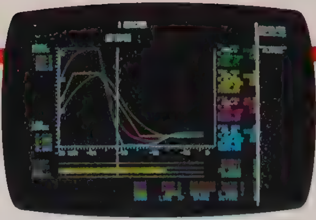
When a fiber-optic data highway is employed to connect several unit process control systems for a centralized plant-wide control system, this unique dual highway loop dramatically reduces the numbers of interconnections and wires. The L&N optical highway *saves* time and labor for connections, material costs, time (costs) in continuity testing of each pathway and troubleshooting during startup. Finally, you eliminate the need for costly protection from ground loops, electromagnetic and radio interference, hazardous atmospheres, moisture and corrosion.

The same control functions can be viewed . . .

as face plates . . .



as graphic picture . . .



as trendlines . . .

4. Faster Arrangement of Control Strategies Saves Time ($) During Startup and Operation

MAX 1 displays are familiar in format for your operators and engineers. No special skills, tools or computer programming is required. The configuring of control programs can even begin before delivery and reconfiguring is simple.

L&N has a *complete* selection of 40 large and powerful control functions (algorithms) so that it is much easier and faster to test and alter trial control strategies . . . that's why it's possible to achieve substantial savings in process *performance* by altering the control methodology.

No special language is needed for data configuration. Configuring of even the most complex strategies with MAX 1 is accepted by many as the easiest in the industry.

5. Minimizes Costs Caused by Process Delays or Upsets

The built-in diagnostics permit quick troubleshooting and even advance warning of possible difficulties. The many types of redundancies allow complete, continued operation, manually or automatically, even if failures occur.

The MAX 1 operator/control system interface is readily understandable, so that the possibility of serious errors is minimized. For example, as a standard feature, MAX 1 displays a summary of alarms in "split screen" view on every Mini-Station (and operator station if an optic highway is involved). These most critical alarms are continuously displayed in every operating view in the priority-established by the plant designer. Finally, emergency shutdown procedures can be built-in to be initiated automatically, by the operator, or a combination of both.

With centralized MAX 1 systems using the dual optical data highways, even external catastrophic conditions—complete severance of both highways, lightning striking one area of the plant, etc.—will not cause the other elements of the control system to fail.

6. Minimal Inventory of Control Components

Not only does MAX 1 require fewer modular hardware components for operation, but also necessarily fewer components for stock. Many, many separate hardware items are eliminated because of the MAX 1 "built-in" functions and interlocks within controller file.

Other examples:

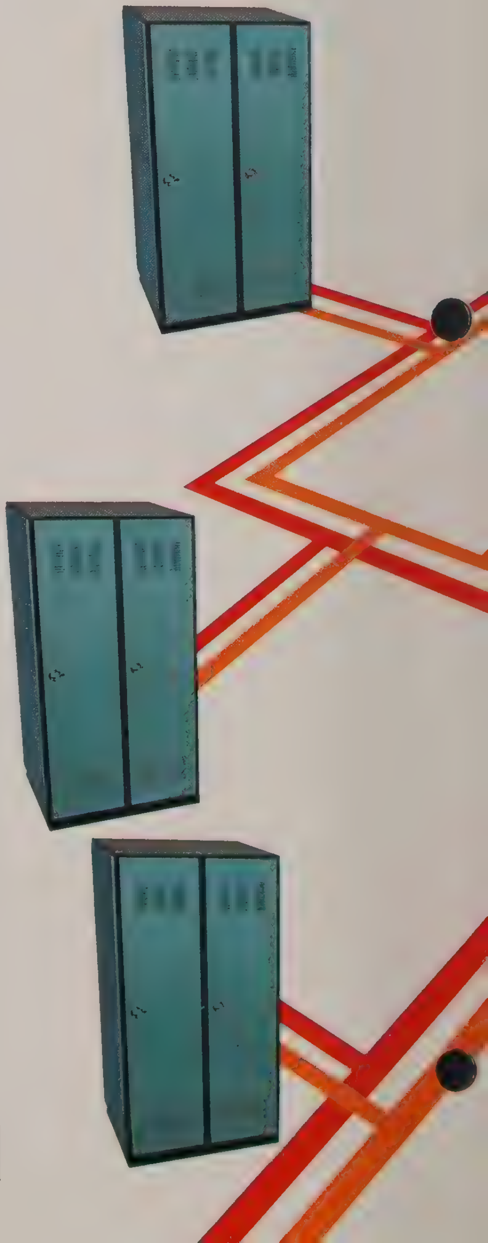
☐ The Mini-Station configures and tunes, as well as operates without need of highway . . .

☐ The operator station needs no extra hardware to develop configurations, tune loops; the operator station will also build graphics, archive data and fully diagnose the system . . .

☐ The optical highway needs no extra components for electromagnetic or radio frequency protection.

7. Much Lower Costs for Future Expansions/Additions

MAX 1 offers easy expandability—you can start with only a few individual control loops and build in a modular manner . . . locally grow up to 64 analog loops and over 1000 discrete actions without a highway . . . link together several of these clusters onto an inter-connecting optical highway for centralized control.



And, if your processes or plant really begins to grow, you can link together as many as four optical highways to centrally located operator stations . . .

Does high level plant optimizing need a central computer? Any "guest" computer is welcome to the MAX 1 system (but a computer is not necessary to drive MAX 1). Some very powerful packages have already been constructed with Digital Equipment Corporation computers.

All from a single-source Supplier

You can obtain everything that makes up any MAX 1 Control System from Leeds & Northrup, one of the founders of the instrument business—all MAX 1 hardware, the transmitters, interlocks, actuators, auxiliary recorders, analyzers, suppliers.

Besides these hardware items, L&N also provides specialized training, complete application and engineering packages, startup service and nearby back-up support from a broad network of sales/service offices.

MAX 1 simply means a better bottom line

The whole idea behind MAX 1 distributed control is to *cut your costs* so that you can achieve greater profitability. MAX 1 has already done this for other firms by varying combinations of other primary benefits noted in this literature, cost-cutting from:

- ☐ Better process performance
- ☐ Fewer pieces of hardware
- ☐ Easier control configuration
- ☐ Quicker response to upsets
- ☐ Smaller inventories
- ☐ Simpler expansion

And, you'll have the assurance of superior, state-of-the-art *security*, plus single-source responsibility and complete service . . . shouldn't we get together?

LOGIC
ON START OPEN
RESET
OFF STOP CLOSE
REV
MODE
MAN
CASC
AUTO
COMP
SET
POIN
GROUP
OVER-VIEW
G1
G2
G3
G4
G6
G7
G8
G9
! 1
" 2
# 3
$ 4
% 5
& 6
/ 7

LEEDS & NORTHRUP SYSTEMS
A UNIT OF GENERAL SIGNAL

We put you in control.

Sumneytown Pike · North Wales, PA 19454
TELEPHONE 215 643-2000 · CABLE ADDRESS "LEEDSNORTH"

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Note: Pricing information pages are pink. Specification data pages are white.

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Calibrating services for L&N precision and semiprecision resistance standards, measuring instruments and sensors are described under the following headings:

(1) L&N Report of Calibration
(2) L&N Letter of Conformance
(3) L&N Calibrating Services - Ordering Information
(4) Traceability of Accuracies of L&N Equipment Calibrations
(5) National Bureau of Standards Report of Calibration or Test

L&N REPORT OF CALIBRATION

Standards and Measuring Instruments

An L&N Report of Calibration is a typed report which includes calibration or correction data, the use of which will improve the accuracy of measurements. Included in the L&N Report are all calibration data usually considered necessary by the National Bureau of Standards. Such calibration data are based on standards maintained by L&N and calibrated periodically by the National Bureau of Standards. The most recent applicable NBS test number and date is included in each report to establish traceability. The data supplied in the L&N Report of Calibration (barring damage or misuse of the product) are reliable to the confidence level given in the report for at least one year from the date of test. On certain products, however, where sufficient long term history of stability has not been accumulated, the data supplied is reliable to the confidence level given only at the time of calibration. In this latter case, a qualifying statement is included in the Report of Calibration.

An L&N Report of Calibration can be prepared only for instruments having accuracy ratings of 0.1% or better. Standards and instruments which qualify for such a report are listed in Tables I, II and III...refer to "L&N Standards and Instruments to which Calibrating Services Apply".

On less precise instruments, the use of correction data will not reliably improve the accuracy of measurements because of operating conditions and/or design characteristics. For these instruments we recommend a "Letter of Conformance" (refer to Table IV), when required, to attest to NBS traceability with a certified statement that the instrument has actually been checked and is within the advertised limits of error.

To obtain the highest degree of precision when comparing resistance standards the use of correction data is mandatory. It has been L&N policy to include a Report of Calibration as part of the selling package on certain precision equipment such as resistance standards, illuminometers, resistance thermometers, reference grade platinum + 10% rhodium vs. platinum thermocouples and the more precise Wheatstone and Mueller bridges (items listed in Table I).

The use of Report of Calibration correction data for other instruments (listed in Tables II and III) will usually improve accuracy of measurements for a period of time by a factor of from two to five depending on particular characteristics of the instrument and measurement involved. A number of Standards Laboratories also use Report of Calibration correction data for evaluating the competance of their laboratory by comparing respective calibrations. Correction Data are also required for determining small errors between successive calibrations and for monitoring long-term stability.

Platinum 10% Rhodium Vs Platinum Thermocouple

Thermocouples are made from selected annealed wire, samples of which have been calibrated at the freezing points of gold, silver, antimony and zinc by the National Bureau of Standards. Because of the high accuracy of this type of calibration (±2 microvolts at each fixed point), and also because of the uniformity in the thermoelectric properties of the wire, the values given in the L&N Report are at least as accurate as if the thermocouple had been calibrated directly by comparison with a standard couple. Using the Report from NBS as a basis, L&N will supply a table giving the emf in absolute millivolts vs. temperature in degrees Celsius in one degree steps from 0 to 1450 C with reference junction at 0 C. (Fahrenheit tables from 32 to 2650 F can be supplied on request.) Maximum length of couple for which this Report will be issued is 60 inches.

L&N Reports will state accuracy comparable to NBS Reports.

Because of the high cost involved in checking individual thermocouples, we do not recommend complete recalibration of used platinum thermocouples. However, thermocouples may develop inhomogeneity (variation in composition along the length of the wires) and contamination with use, and either condition will introduce calibration errors. Therefore periodic limited recalibration is essential and we recommend a two-point check at approximately 1000 and 1850 F for used platinum thermocouples (minimum length accepted for recalibration is 24 inches). If calibration is validated at these points the original tables will be reissued or the Thermocouple Conversion Tables Booklet will be used, whichever is applicable.

Refer to Section 1.1-1-2.

18702-B-□ (which includes an L&N Report) has limits of error as follows with respect to L&N Standard Thermocouple Conversion Tables: 0 to 1000 F ±1.5 F, 1000 to 2700 F ±0.15%. 18702-□ (without L&N Report) has limits of error as follows, using L&N Standard Thermocouple Conversion Tables: 0 to 1000 F ±2.5 F, 1000 to 2700 F ±0.25%. The fee for an L&N Report is included in listed prices of all "B" suffix platinum couples and Std 1784 and Std 1784-A elements.

NOTE: Thermocouple Report of Calibration for platinum couples includes two separate calibrations, one referenced to IPTS-48 and one referenced to IPTS-68.

L&N LETTER OF CONFORMANCE

A "Letter of Conformance" is a statement that a particular instrument, apparatus or component has been constructed in accordance with advertised specifications and has the accuracy claimed for it; when practical, NBS traceability is also stated.

The Letter of Conformance is based on established test and inspection methods of goods produced. It is prepared by the Corporate Standards Laboratory, approved by the Quality Assurance Manager, and notarized. This service is provided on request only and no fee is applied to new equipment orders.

To obtain a letter of Conformance for new instruments, a special note must be indicated on the order specifying the certification requirements for the item involved. The "Letter" will accompany instruments made on the order. The "Letter" will be mailed separately for "Shelf Goods" Items.

For a fee, an L&N Letter of Conformance can be supplied on instruments returned for recalibration (without repairs) but which do not qualify for a "Report of Calibration". Fees are listed in Table IV.

A "Letter of Conformance" can also be supplied as an alternate certificate for instruments which do qualify for a Report of Calibration as listed in Table II, but for which customers only require standard accuracy (do not need or use correction data provided in Report of Calibration). Fees are listed in Table V.

Cleaning of switches, contacts and slidewire, replacement of batteries and other routine maintenance items are included as part of the service in preparing the Letter of Conformance. If repairs are required, additional charges will apply. A repair report will be issued specifying the nature of repair and charges involved before the work is committed.

Items Returned for Repair

When an instrument is returned for repairs a "Letter of Conformance" can be supplied on request:

a. *Without charge,* if repair charges are equal to or greater than the listed fee for Letter of Conformance in Tables IV or V
b. *with charge* of listed fee for Letter of Conformance, if repair charges total less than listed fee in Tables IV or V.

L&N CALIBRATION SERVICES

Ordering Information

When a Report of Calibration is required with new instruments (Table II), specify on order by adding the suffix "-B" to catalog number and calibration fee to selling price. When report is specified at same time as the instrument or standard is purchased, the fees listed in Table II are subject to a 20% discount.

Standards and instruments listed in the following five tables may be sent by customers to L&N for calibration or returned periodically for recalibration. Fees for this service are shown in the tables.

When an "as received" calibration check is requested, the customer's order and returned goods tag must clearly specify this requirement. The instrument is then checked prior to any routine cleaning of contacts and slidewires or replacement of components, including batteries. An "as received" calibration check provides the customer with the assurance that his instrument has maintained it's accuracy between recalibrations, or informs him of the degree of error when received.

Normal repair order procedures should be followed in handling such transactions except calibration fees should be quoted in advance in order to expedite delivery. A returned goods tag (Form 154-49-0) addressed to "Leeds & Northrup Co., Receiving Dept., Sumneytown Pike, North Wales, Pa., 19454" should be supplied to the customer and attached to the instrument when it is shipped to us.

Check block mark "Returned for Calibration" and under "Comments" specify Report of Calibration or Letter of Conformance. Also specify "As Received" calibration check, when applicable.

Shipments of standards and instruments sent to L&N must be properly packed to minimize the likelihood of damage in transit or handling and must be clearly identified (associated with the customer's purchase order). Risk of loss or damage must be assumed by the customer...likewise, shipping charges to and from L&N.

L&N reserves the right to refuse to accept for test any apparatus not in good condition unless repairable and unless authorized to proceed with the required repairs.

Refer to Marketing Procedure 19 for information on calibration and checking of equipment consigned to field offices for full service testing including Report of Calibration or Letter of Conformance.

L&N STANDARDS AND INSTRUMENTS TO WHICH L&N CALIBRATING SERVICES APPLY

TABLE I – L&N REPORT OF CALIBRATION . . . INCLUDED IN LIST PRICE OF PRODUCT

These instruments are always furnished with a Report of Calibration. Total price is price of item plus listed fee for L&N Report of Calibration. The fees also apply to recertifications. †

CATALOG NO.	ITEM[1]	FEE †
4015-B	Resistance Standard	$ 160.00
4020-B	Resistance Standard	185.00
4025-B	Resistance Standard	185.00
4030-B	Resistance Standard	160.00
4035-B	Resistance Standard	160.00
4040-B	Resistance Standard	160.00
4045-B	Resistance Standard	160.00
4050-B	Resistance Standard	185.00
4020-B to 4050-B	Resistance Standards Temp Coeff Data . . .	
	2 Terminal	295.00
	4 Terminal	295.00
4020-B-X□ to 4040-B-X□	Resistance Standards Intermediate & Odd Value . . .	230.00[2]
	2 Terminal	230.00[2]
	4 Terminal	230.00[2]
4210-B	Thomas Type 1-Ω Std:	
	Recheck of Value	280.00
	" & Temp Coeff Data	530.00
4214-B	Resistance Standard	435.00
4221-B to 4223-B	Resistance Standard Temp Coeff Data . . .	360.00[2]
4221-B	Resistance Standard	185.00
4222-B	Resistance Standard	185.00
4223-B	Resistance Standard	210.00
4221-B-X□ to 4222-B-X□	Resistance Standards Intermediate & Odd Value . . .	225.00
4224-B-A150	Resistance Standard	225.00
4232-3-B	Wheatstone Bridge	1654.00
4321-B	Hamon Transfer Std	815.00
4323-B	Hamon Transfer Std	815.00

CATALOG NO.	ITEM[1]	FEE
7311[4]	Standard Voltage Ref	$ 716.00
8070-B	Calibrating Resistor	230.00
8079-B	Thermometer Bridge, ER	2300.00
8167-25-B[5]	Platinum Resistance Therm	1210.00
8167-25-C[5]	Platinum Resistance Therm	850.00
18700-B-□[7]	Platinum Couple	350.00
18702-B-□[7]	Platinum Couple	350.00
18710-B-K2002-□-□[7]	Platinum Couple	350.00
18710-B-K2025-□-□[7]	Platinum Couple	350.00
Std 1784-□[7]	Platinum Couple	350.00
Std 1784-A-□[7]	Platinum Couple	350.00

[1] When an instrument which is part of measuring facility is to be returned for recalibration, it is necessary to return only the instrument, not the complete facility. This applies to Tables I, II, III.

[2] Applicable to recertification only, includes L&N Report of Calibration and temperature coefficient data.

[5] L&N Calibration data supplied in tabular form in one degree intervals. Calibrations will be made on the new International Practical Temperature Scale of 1968 (IPTS-68) with a current of one milliampere through the thermometer unless otherwise specified. Options: IPTS-68 with two milliamperes and IPTS-48 with one or two milliamperes.

[7] Calibration will include 1 degree C interval tables over entire range of 0 to 1450 C unless otherwise specified. Report of Calibration includes correction to IPTS-68.

Option: Tables over the range of 32 to 2650 F in one degree F intervals. Note: If both C and F tables are requested, add **$100.00.**

† When customers order for recertification includes a request for an "As Received" calibration check, the fee is doubled. Example: Fee is **$125.00**, request for "as received" calibration check increases total fee to **$250.00**.

L&N STANDARDS AND INSTRUMENTS TO WHICH L&N CALIBRATING SERVICES APPLY

TABLE II—L&N REPORT OF CALIBRATION . . . OPTIONAL (ADD FEE TO LIST OF PRODUCT)[2]

These instruments are not automatically furnished with a Report of Calibration. When a report is required, specify by adding suffix -B to catalog number and calibration fee to selling price. When report is specified at same time instrument or standard is purchased, the fees listed below are subject to a 20% discount. For recertifications the fees are as listed (no discount).† Unless stated otherwise in the Equipment Price list, the addition of an L&N Report of Calibration to instruments which are normally stocked, will change their status to "nonstocked", delivery of normally stocked instruments will be approximately two weeks when report is specified.

Cat. No.	Item[1]	Fee[2]†
4287-2, -3	Precision DC Kelvin Bridge	**$ 900.00**
4289-2	Wheatstone Bridge	**900.00**
4300	Kelvin Bridge	**1055.00**
4320	Kelvin Bridge Ratio Box	**600.00**
4333	Resistance Standard	**160.00**
4334	Resistance Standard	**160.00**
4360[3]	Shunt (15 amperes)	**520.00**
4361[3]	Shunt (100 amperes)	**605.00**
4363[3]	Shunt (300 amperes)	**605.00**
4385[4]	Shunt Box	**1130.00**
4360[5]	Shunt (15 amperes)	**365.00**
4361[5]	Shunt (100 amperes)	**365.00**
4363[5]	Shunt (300 amperes)	**365.00**
4385[5]	Shunt Box	**520.00**
4393-2	Universal Ratio Set	**1288.00**
4395	Voltage Divider	**760.00**
4398-M	Double Ratio Set, 7-Dial	**1628.00**
4736	Wheatstone Bridge	**1000.00**
4737	Wheatstone Bridge	**1200.00**
4754	AC Resistance Box	**630.00**
4755	AC Resistance Box	**765.00**
4756	AC Resistance Box	**765.00**
4757	AC Resistance Box	**865.00**
4872	Hoopes Standard (ONLY)	**490.00**
	Hoopes Conductivity Sample Wire	**435.00**

Cat. No.	Item[1]	Fee[2]†
7308	Standard Cell	**$ 175.00**
7554	Type K-4 Potentiometer	**710.00**
7555	Type K-5 Potentiometer	**925.00**
7556	Type K-6 Potentiometer	**1140.00**
7564	Differential Potentiometer	**1300.00**
7582[6]	Volt Box	**550.00**
7592[6]	Volt Box	**860.00**
7593[6]	Volt Box	**885.00**
7582[7]	Volt Box	**330.00**
7592[7]	Volt Box	**555.00**
7593[7]	Volt Box	**535.00**
7594	Volt Box Standard	**1380.00**
7594-2	Volt Box Standard 1500 V	**1815.00**
8064	Res. Thermometer Bridge	**740.00**
8064-A	Res. Thermometer Bridge	**840.00**
8067	Mueller Bridge, G-1	**1463.00**
8627-1, -2[8]	Optical Pyrometer	**750.00**
8627-3,-4,-5,-6[8]	Optical Pyrometer	**950.00**
8686[9]	Millivolt Potentiometer	**620.00**
8687[9]	Volt Potentiometer	**650.00**
8690-2[9]	Millivolt Potentiometer	**520.00**
8691-2[9]	Millivolt Potentiometer	**520.00**

---

1 *When an instrument is part of a measuring facility, only the instrument should be returned for recalibration, not the complete facility (the -A□ facilities).*

2 *Fees in Table II are subject to 20% discount when L&N Report of Calibration is purchased at same time as the standard or instrument. For L&N Report of Calibration for items not listed, contact EIC for availability and fee.*

3 *Calibration at 20%, 50% and 100% of rated currents.*

4 *Calibration at 20% and 100% of rated current. For additional calibration at 50% of rated current, add* **$ 340.00**

5 *Calibration at 20% of rated current; recommended for recalibration only.*

6 *Calibration at 20% and 100% rated voltage.*

7 *Calibration at 100% rated voltage; recommended for recalibrations only.*

8 ***Three points each range. Additional points add $ 40.00 per point.***

9 ***With -R Option (Run-up Box), add $ 90.00.***

† *When customer's order for recalibration includes a request for an "as received" calibration check, the fee is doubled. Example: Fee is* **$ 125.00,** *request for "as received" calibration check increases total fee to* **$ 250.00.**

L&N STANDARDS AND INSTRUMENTS TO WHICH L&N CALIBRATING SERVICES APPLY

TABLE III -OBSOLETE ITEMS FOR WHICH L&N REPORTS OF CALIBRATION CAN BE SUPPLIED[1]†

These instruments are no longer available for sale. As a service, however, we will certify them at the fees listed.

Cat. No.	Item	Fee†
4205-09	Resistance Standard	**$ 115.00**
4224-B-A300	Resistance Standard	**345.00**
4230	Bridge (Anthony)	**1680.00**
4232	Precision Guarded Wheatstone Bridge	**2000.00**
4247	Tenth-Megohm Resistance Box	**160.00**
4306	Kelvin Bridge	**605.00**
4364[7]	Shunt (500 Amp)	**310.00**
4391	Direct Reading Ratio Set	**882.00**
4392	Wenner Ratio Box	**836.00**
4394	Kel-Wheatstone Ratio Set	**1045.00**
4397-M	Voltage Divider	**840.00**
4398	Double Ratio Set	**1680.00**
4399	Precision Potential Div.	**1905.00**
4725	Wheatstone Bridge	**1355.00**
4725 Special	Double Ratio Set (5 Dial)	**1420.00**
4735	Wheatstone Bridge	**1400.00**
4790	Microhm Decade Box	**1475.00**
7309[3]	Standard Cell	**169.00**
7551	Type K-1 Potentiometer	**710.00**
7552	Type K-2 Potentiometer	**710.00**
7553-5	Type K-3 Potentiometer	**710.00**
7553-6	Type K-3 Potentiometer	**710.00**
7565	Standard Cell Comparator	**922.00**
7581[4]	Volt Box	**815.00**
7581[5]	Volt Box	**440.00**

Cat. No.	Item	Fee†
7591	Volt Box	**$ 920.00**
7591	Volt Box	**565.00**
7591-S	Volt Box (1 extra range)	**1035.00**
7591-S	Volt Box (2 extra ranges)	**1140.00**
7591-S	Volt Box (1 extra range)	**600.00**
7591-S	Volt Box (2 extra ranges)	**610.00**
7594	Volt Box Standard	**1385.00**
7594-S	Volt Box (10 taps)	**1145.00**
8069	G-2 Mueller Bridge	**2320.00**
8071-B	G-3 Mueller Bridge	**2415.00**
8163-B	Platinum Res. Thermometer	**1215.00**
8163-C	Platinum Res. Thermometer	**850.00**
8621-F or C	Optical Pyrometer	**910.00**
8622-F or C	Optical Pyrometer	**1220.00**
8623-F or C	Optical Pyrometer	**1220.00**
8626-C	Optical Pyrometer	**1220.00**
8631-F or C	Optical Pyrometer	**785.00**
8632-F or C	Optical Pyrometer	**1065.00**
8633-F or C	Optical Pyrometer	**1065.00**
8634	Optical Pyrometer	**1430.00**
8636-C	Optical Pyrometer	**1065.00**
8662	Millivolt Potentiometer	**945.00**
8690	Millivolt Potentiometer	**640.00**
8691	Millivolt Potentiometer	**700.00**
8690-1	Millivolt Potentiometer	**730.00**
8691-1	Millivolt Potentiometer	**730.00**

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1 *For Report of Calibration for instruments not listed, contact EIC, North Wales for availability and fee.*

2 *Refer to the 8160 Series High Precision Platinum Resistance Thermometers in "Product Specifications", for details of L&N Calibration data supplied in tabular form in one degree intervals. Calibrations will be made on the new International Practical Temperature Scale of 1968 (IPTS-68) with a current of one milliampere through the thermometer unless otherwise specified. Option: IPTS-68 with two milliamperes . . . add* **$ 95.00**

3 *Eppley Calibration Report supplied with standard item which gives general statement of NBS traceability. L&N Report, for additional fee, states direct traceability.*

4 *Calibration at 20% and 100% of rated voltage.*

5 *Calibration at 100% of rated voltage; recommended for recalibrations only.*

7 *Calibration at 20% of rated currents; recommended for recalibrations only.*

8 *Three points each range.*

† *When customer's order for Recalibration includes a request for an "As Received" Calibration Check, the fee is doubled. Example: Fee is $ 125.00, request for "As Received" calibration check increases total fee to $ 250.00.*

L&N STANDARDS AND INSTRUMENTS TO WHICH L&N CALIBRATING SERVICES APPLY

TABLE IV – L&N LETTER OF CONFORMANCE

(Items do not qualify for Report of Calibration)

Fee applies to recalibration only.† List includes obsolete as well as items currently manufactured. This service is available for other equipment for which fees have not been set.

CATALOG NO.	ITEM	FEE †
913-914	Numatron	$ 428.00
923	Numatron	295.00
4282	Ohmmeter	345.00
4285	Kelvin Bridge Ohmmeter	610.00
4286	Kelvin Bridge Ohmmeter	355.00
4288	Kelvin Bridge Ohmmeter	390.00
4775, 4776	Resistance Box	225.00
4866	Conductivity Bridge	465.00
4959	Conductivity Bridge	465.00
5300	Test Set	380.00
5305	Test Set	380.00
5430-A	Test Set	380.00
4283	Wheatstone Bridge	390.00
4760	Wheatstone Bridge	350.00
7659	Potentiometer	480.00

CATALOG NO.	ITEM	FEE †
8017	Wheatstone Bridge	$ 390.00
8692	Potentiometer	345.00
8693	Potentiometer	465.00
8694	Potentiometer	345.00
8695	Potentiometer	485.00
8696	Potentiometer	485.00
8697	Potentiometer	485.00
9828, 9838	Null Detector	325.00
9877	Power Supply	215.00
9878, 9879	Power Supply	220.00
099034	Power Supply	180.00
9912	Run-Up Box	115.00
9914	Control Loop Tester	115.00

TABLE V – L&N LETTER OF CONFORMANCE

Fee applies to recalibration only:† List includes obsolete as well as items currently manufactured. This service is available for other equipment for which fees have not been set.

CATALOG NO	ITEM	FEE †
4271	Wheststone-Limit Bridge	$ 810.00
4283	Wheatstone Bridge	390.00
4287-2	Kelvin Bridge	700.00
4289-2	Wheatstone Bridge	700.00
4300	Adj. Low Res. Std	675.00
4360	Shunt (15 Amperes)	345.00
4361	Shunt (100 Amperes)	345.00
4320	Kelvin Ratio Box	440.00
4385	Shunt Box	415.00
4395	Voltage Divider	565.00
4398-M	Double Ratio Set	1160.00
4399	Precision Potentional Divider	1015.00
4725	Wheatstone Bridge	700.00
4735	Wheatstone Bridge	700.00
4736	Wheatstone Bridge	700.00
4737	Wheatstone Bridge	765.00
4754	A-C Resistance Box	425.00
4755	A-C Resistance Box	425.00
4756	A-C Resistance Box	425.00
4764	A-C Resistance Box	460.00
7551, 7552	Potentiometer	620.00
7553	Potentiometer	620.00
7554	Potentiometer	620.00
7555	Potentiometer	775.00
7556	Potentiometer	775.00

CATALOG NO.	ITEM	FEE †
7564	Differential Potentiometer	$ 890.00
7581	Volt Box	425.00
7582	Volt Box	425.00
7591	Volt Box	425.00
7592	Volt Box	345.00
7593	Volt Box	380.00
8067	Mueller Bridge	855.00
8621-F or C	Optical Pyrometer	515.00
8622-F or C	Optical Pyrometer	695.00
8623-F or C	Optical Pyrometer	695.00
8626-F or C	Optical Pyrometer	695.00
8627	Optical Pyrometer	640.00
8631 F or C	Optical Pyrometer	465.00
8632 F or C	Optical Pyrometer	695.00
8633 F or C	Optical Pyrometer	695.00
8634 F or C	Optical Pyrometer	870.00
8636-C	Optical Pyrometer	695.00
8686	Millivolt Potentiometer	480.00
8687	Volt Potentiometer	515.00
8690-1 or -2	Millivolt Potentiometer	400.00
8691-1 or -2	Millivolt Potentiometer	400.00
9696	Calibrator/Tester	520.00

1. Three-point check each range.

† When customer's order for recalibration includes a request for an "as received" calibration check, the fee is doubled. Example:– Fee is **$125.00** request for "as received" calibration check increases total fee to **$250.00**

TRACEABILITY OF ACCURACIES OF L&N EQUIPMENT CALIBRATIONS

Customers frequently ask about the traceability of L&N equipment calibrations to the national electrical and temperature standards as maintained by the National Bureau of Standards. Questions can be easily answered by informing the customer about L&N's calibration procedures. They are:

(1) Every L&N calibration is based upon the legal standards of the U.S. Government maintained by the NBS. We currently maintain the calibration of about 2000 standards and standard instruments including precision bridges, potentiometers and other transfer instruments to insure the accurate measurement of capacitance, inductance, resistance, voltage, current, temperature, etc. These are compared at regular intervals with primary standards.

Our three sets of primary standards of resistance and voltage have a particularly long history of stability. They have been calibrated many times, over a period of more than a quarter of a century, by the National Bureau of Standards. Individual sets are calibrated by the NBS at intervals of one year or less. About 800 working standards of the Thomas, NBS and Reichsanstalt type are referenced at regular intervals to these three sets of primary standards.

(2) Proof of these calibrations is available to customers in two forms. A "Letter of Conformance" can be issued on request stating that the instrument has been constructed in accordance with advertised specifications and has the accuracy claimed for it. Alternatively, an "L&N Report of Calibration" can be obtained for those instruments which are suitable for this quality of certification, (see preceding pages). "L&N Report of Calibration" provides a table or equation of corrections in addition to an accuracy statement.

All L&N Reports of Calibration and Letters of Conformance (when applicable) carry a statement attesting to the calibration of L&N standards at regular intervals by NBS and record the most recent applicable NBS test number and test date. We believe that the integrity and reputation of the manufacturer, and the technical competance required to transfer NBS calibration of standards to products, is most important. In fact, we maintain our calibrations so close to those of NBS that we invite and encourage comparison of values.

(3) Refer to Marketing Procedure 19 for information on traceability of accuracies of equipment consigned to field offices for field service testing.

We are not prepared to undertake the formidable clerical work which would be required to provide, with either form of report, a complete listing of the reference standards used in the calibration of a particular instrument. The integrity of our calibration chain is fully assured by the individual calibration and correction data kept on all of our "Lab Tool" instruments and standards. In addition, most instruments are checked more than once in the course of manufacture by instrument makers using different "Lab Tools" and different checking techniques. Recorded data on calibration and checks includes, of course, a callout of the "Lab Tools" used.

Interest in traceability statements and proof of traceability is, to a large extent, the result of exaggerated claims about accuracy of measurement by various people. You have undoubtedly had instances where prospects have compared our advertised claims to competitive ones to our disadvantage. Perhaps you have lost orders because customers have believed a competitor. Traceability can be a powerful sales tool to our advantage, when we remember that the customer insisting upon it is merely insisting upon the orderly calibration practice which L&N has always followed.

NATIONAL BUREAU OF STANDARDS REPORT OF CALIBRATION OR TEST

Customers desiring an NBS report of calibration or test for L&N Instruments are to negotiate directly with the National Bureau of Standards.

Direct Inquiries to the attention of:

Electrical Measurements and Standards Div.
MET-B146, National Bureau of Standards
Washington, DC 20234

Telephone (301) 921-2715

For full description of services available from NBS consult special publication 250, "Calibration and related measurement services of NBS", write or call Office of Measurement Services, National Bureau of Standards, Physics Bldg., Room B362, Washington, DC 20234; (301) 921-2805.

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8686-3 PORTABLE MILLIVOLT POTENTIOMETER

A
B
C
GALVANOMETER
STANDARDIZE
GALV OFF

ADVANTAGES

- Self-contained — built-in solid state null detector, standard cell and batteries
- Two ranges — one measures below 0 mV without input reversal, covers entire range of thermocouples — one covers standard cell voltages for fast checks of other instruments
- Best of L&N portables for accuracy — ± (0.03% of reading +3 microvolts)
- Convenient to use as a source of calibrated EMF for checking null balance circuits
- Optional Run-Up Box — for calibrating instruments requiring current flow for operation — for dynamic checking of null-balance instruments which require low impedance sources

FEATURES

- Self-contained — built-in lamp-and-scale galvanometer, standard cell and batteries
- Central reading window — single row of digits plus a scale reading
- Convenient standard cell adjustment for long term changes in voltage
- Slidewire overlap — eliminates dial-switch operation for small voltage changes
- Manual reference junction compensator for thermocouple measurements

POTENTIOMETERS

Double range, direct reading, three dial

Cat. No. 8687-2 *Type:* Portable, self-contained; *DC Null Detector:* 2437-2-10 Electronic Null Detector: continuously adjustable sensitivity high impedance (see 10.7-1-3); *Power Supply:* Batteries (see 10.8-1-1).

Cat. No. 8687-3 *Type:* Portable, self-contained; *DC Null Detector:* Solid-state Null Detector similar to 324190; *Power Supply:* Batteries (see 10.8-1-1).

APPLICATION

Used for calibration of dc ammeters, voltmeters, checking recorders, controllers, and similar instruments. Used for the precise measurement of temperature when used with thermocouples; for measurements of pH, oxidation/reduction, and other potential measurements.

SPECIFICATIONS FOR 8687-2 and -3 PORTABLES

HIGH RANGE

Range 0 to 1.601 V
Limit of Error ± (0.03% of reading +30 uV)
Measuring Dials *A Switch:* 15 x 0.1 V; *B Switch:* 9 x 0.01 V; *C Slidewire:* 0 x 0.011 V, Smallest div. 50 uV.
Resolution 10 microvolts

LOW RANGE

Range 0 to 0.1601 V
Limit of Error ± (0.04% of reading +3 uV)
Measuring Dials *A Switch:* 15 x 0.01 V; *B Switch:* 9 x 0.001 V; *C Slidewire:* 0 x 0.0011 V, Smallest div. 5 uV.
Resolution 10 microvolts

Readout All dial readings, except the decimal multipliers, appear in a central readout window and are displayed as a series of digits plus a scale interpolation.

Function Switch 9-Position switch to provide the following internal instrument connections as switch is rotated clockwise:

(1) "GALV OFF"; (2) "STANDARDIZE"; (3) "MEASURE x 1.0"; (4) "MEASURE x 0.1"; (5) "STANDARDIZE"; (6) "OUTPUT x 1.0"; (7) "OUTPUT x 0.1"; (8) "STANDARDIZE"; (9) "GALV OFF"

With three "STANDARDIZE" positions, instrument can be standardized by rotating the switch a single step.

Meas. Range	Res. uV/Div (1.5 mm)	Sensitivity/Division		
		8687 1 Div=1 mm	8687-2 1 Div=1.6 mm	8687-3 1 Div=1.5 mm
X1	25	27 uV	0.5 uV	5 uV
X0.1	2.5	27 uV	0.5 uV	5 uV

Keys Two galvanometer sensitivity keys. One lock-down type.

Power Supply One 3 V battery for measuring circuit. Two batteries for detector. Self-contained. Battery life (detector): 2000 hrs operation or 10 months, whichever is less.

Rheostats "COARSE" and "FINE" for adjustment of battery current.

Standard Cell Adjustment Recessed, slotted shaft for internal slidewire provides adjustment for any standard cell voltage from 1.0170 to 1.0200 V.

Case Metal with vinyl finish, handle and removable lid. Operating directions carried in lid of case.

Dims. 14-5/16" x 11-1/32" x 7-3/8" (364 x 280 x 187 mm)

Weight Net approx. 21 lb (9.5 kg); shipping, approx. 26 lb (11.8 kg)

OPTIONS FOR 8687 SERIES

Suffix B L&N Report of Calibration. Using correction shown on these reports, the limits of error at 25°C are: *High Range:* ± (0.02% +20 uV). *Low Range:* ± (0.02% +2 uV)

OPTIONAL ACCESSORIES FOR 8687 SERIES

124179	Cleaner-Lubricant for slidewire
9912	Run-Up Box
2437-2-□	DC Electronic Null Detector: component type to replace galvanometer of 8687 (see 10.7-1-3)
324190	Kit. Solid State Null Detector. Designed to replace the light beam galvanometer in the early model 8687 Potentiometer.

NOTE: CAT 8687 Millivolt Potentiometer with galvanometer type detector was withdrawn in OCT. 1989.

NOTE:
For applications where mercury is undesirable, the standard cell can be encapsulated in epoxy resin. Specify 130080 (includes mounting bracket).

POTENTIOMETERS

Double-range, three-dial for laboratory and plant

Cat. No. 8686-2 *Type:* Portable, self-contained; *DC Null Detectors:* 2437-2-1C Electronic Null Detector continuously adjustable sensitivity, high impedance (see 10.7-1-3); *Power Supply:* Batteries (see 10.8-1-1).

Cat. No. 8686-3 *Type:* Portable self-contained; *DC Null Detectors:* Solid State Null Detector similar to 324190 (see 10.7-1-3); *Power Supply:* Batteries (see 10.8-1-1).

APPLICATION

For measurement of temperatures with base or noble-metal thermocouples; checking standard cell voltages in other instruments and checking thermocouples; accurate measurements of the output of transducers such as strain gages, thermopiles, etc., as a source of calibrated EMF (not designed to supply current); and in combination with the 9912 Run-Up Box for calibrating instruments which require current flow for operation, such as deflection-type millivolt indicators, and for the dynamic checking of low-millivoltage Micromax Recorders or similar null balance instruments which require low-impedance sources.

SPECIFICATIONS FOR 8686-2 AND 8686-3 PORTABLES

Range (1) −10.0 to +100.1 mV without input reversal; (2) +1010 to + 1020 mV for standard cell calibration.

Limits of Error *Without Reference Junction Compensation* ± (0.03% of reading +3 uV); *With Reference Junction Compensation* ± (0.03% of reading +6 uV).
For Limit of Error with L&N Report of Calibration, see Option B.

Meas. Dials *A Switch:* 9 x 10 mV plus additional step of 1010 mV and a minus (−) position; *B Switch:* 9 x 1 mV; *C Slidewire:* 0 to 1.1 mV on circular scale 12″ long.

Smallest Scale Div. 5 microvolts

Resolution 1 microvolts

Readout All dial readings appear in a central readout window and are displayed as a series of digits plus a scale interpolation.

Ref Jct Compensator Uncalibrated multi-turn slidewire manually operated. Range 0 to 5 mV, adjustable to 2 uV.

Function Switch 9-Position switch to provide the following internal instrument connections as switch is rotated clockwise: (1) "GALV OFF"; (2) "STANDARDIZE"; (3) "EMF MEASURE"; (4) "EMF OUTPUT"; (5) "STANDARDIZE"; (6) "TC OUTPUT"; (7) "TC MEASURE"; (8) "STANDARDIZE"; (9) "REF JCT".
With three "STANDARDIZE" positions, instrument can be standardized by rotating the switch a single step.

Resolution uV/Div (1.5 mm)	Sensitivity/Division		
	...	8686-2 1 Div=1.6 mm	8686-3 1 Div=1.5 mm
5		0.5 uV	5 uV

Keys Two galvanometer sensitivity keys. One lock-down type.

Power Supply One 1-1/2 V battery for measuring circuit. Two batteries for detector. Self-contained. Battery life (detector): 2000 hrs operation or 10 months, whichever is less.

Rheostats "COARSE" and "FINE" for adjustment of battery current.

Standard Cell Adjustment Internal slidewire provides adjustment for any standard cell voltage from 1.0170 to 1.0200 V.

Case Metal with vinyl finish, handle and removable lid. Operating directions and conversion tables for thermocouple included (carried in lid of case).

Dims. 14-5/16″ x 11-1/32″ x 7-3/8″ (364 x 280 x 187 mm)

Weight Net approx. 21 lb (9.5 kg); shipping, approx. 26 lb (11.8 kg)

OPTIONS FOR 8686 SERIES

Suffix B L&N Report of Calibration. Using corrections shown on these reports, the limits of error at 25°C are: *Without Ref. Jct. Comp.:* ±(0.02% +2 uV). *With Ref. Jct. Comp.:* ±(0.02% +4 uV)

OPTIONAL ACCESSORIES FOR 8686 SERIES

2437-2-☐	DC Electronic Null Detector: component type to replace galvanometer of 8686 (see 10.7-1-3)
9912	Run-Up Box
324190	Kit. Solid State Null Detector. Designed to replace the light beam galvanometer in the 8686 Potentiometer.

NOTE: CAT *8686 Millivolt Potentiometer with galvanometer type detector was withdrawn in OCT. 1989.

NOTE:
For applications where mercury is undesirable, the standard cell can be encapsulated in epoxy resin. Specify 130080 (includes mounting bracket).

8690-2 PORTABLE MILLIVOLT POTENTIOMETER

- Measurements from -11.0 to +101.0 mV
- Decade and slidewire operation with in-line readout
- Long 27.5" scale provides high resolution for precise readings
- Slidewire overlap eliminates decade operation for small voltage changes
- Self contained; built-in electronic null detector, standard cell and batteries
- Measures below 0 mV without input reversal
- Useful for routine checking of thermocouples, recorders and controllers
- Manual reference-junction compensator for T.C. measurement
- Provides calibrated D.C. source for calibration of meters, potentiometers, recorders, etc.

SPECIFICATIONS

Catalog Number 8690-2, Portable Millivolt Potentiometer.

Range -11.0 mV to +101.0 mV

Limits of Error★ Without reference junction compensation: ± (0.05% of reading +15 uV); With reference junction compensation: ± (0.05% of reading +30 uV).

Max. External Resistance Approx. 1000 ohms

Measuring Dials Millivolt dial: 9 x 10 mV plus a minus (-) position; Slidewire: 0 to 11 mV, two-turn, 27.5" long.

Smallest Scale Div. 20 microvolts.

Resolution 5 microvolts.

Reference Junction Compensator Uncalibrated, multi-turn. Range 0 to 5 mV. Adjustable to 5 uV.

Standard Cell Adjustment Recessed. Provides adjustment for standard cell voltages from 1.0170 V to 1.0200 V.

Detector Solid-state; *Sensitivity:* 50 uV per div.; *Noise:* <10 uV peak to peak; *Input-Resistance:* 10,000 ohms; *Common Mode Rejection:* >132 dB; *Normal Mode Rejection:* >70 dB; *Zero Adjustment Range:* ±15 mV; *Response Time:* <1 second; *Zero Stability:* Time, <10 uV/hr noncumulative; *Temp.,* < 10 uV/°C; *Source Resistance:* <10 uV for 1000 ohm change. *Overload Recovery Time:* < one second for 1 V overload. *Max. Overload:* 2 V.

Battery Rheostat Ten-turn. For adjustment of battery current.

Function Switch 7-Position: (1) "OFF"; (2) "EMF OUTPUT"; (3) "EMF MEASURE"; (4) "STANDARDIZE"; (5) "TC MEASURE"; (6) "TC OUTPUT"; (7) "REF JCT".

Detector Key Lock-down.

Batteries Self-contained. One 1.5 V dry cell for measuring circuit. Life of batteries is over 1000 hrs continuous duty, or over 1 year at 4 hrs/day, 5 days/week.

Case Metal with handle and removable lid.

Dimensions 12-11/32" x 8-29/32" x 7-9/16" (314 x 226 x 192 mm).

Weight Net, about 13 lb (5.897 kg); shipping, about 17 lb (7.711 kg)

Directions Operating directions and Thermocouple Conversion Tables included. Stored in lid.

Options L&N Report of calibration (add suffix B to Cat. No.)

Run-Up Box, mounted in lid of potentiometer (add suffix R to Cat. No.); *Output Ranges:* 0 to 60 mV and 60 to 120 mV adjustable to better than +0.02 mV. *Output Resistance:* 0 to 25 ohms adjustable within ±0.5 ohm. Includes two-conductor, color-coded cable with lugs for connections.

OPTIONAL ACCESSORIES

9912 Run-Up Box.

8690 REPLACEMENT PARTS

324050 Solid-State Null Detector Kit to replace the pointer galvanometer in earlier potentiometers. Results in increased sensitivity and permits use of higher external resistances. For specs see 10.7-1-9.

★ *Using corrections shown on the L&N Report of Calibration, the limits of error at 25° C are . . . Without Reference Junction Compensation: ± (0.02% +10 uV); With Reference Junction Compensation: ± (0.02% +20 uV).*

NOTE:

For applications where mercury is undesirable, the standard cell can be encapsulated in epoxy resin. Specify Part No. 130080 (includes mounting bracket). The 056056 Mercury Batteries which power the detector can be replaced with Eveready 333 (4.5 V) carbon-zinc batteries, or equivalent.

8691-2 PORTABLE MILLIVOLT POTENTIOMETER

A double-range, direct reading, single dial plus two-turn slidewire potentiometer for general laboratory and plant use.

APPLICATION

- For measuring the output of thermocouples, thermal converters, strain gages and other transducers.
- Convenient to use as a source of calibrated EMF for checking other instruments, recorders, controllers.

SPECIAL FEATURES

Except for function legends and omission of R.J. compensator, similar in appearance to 8690-2.

- Self-contained . . . built-in solid-state null type detector, standard cell, and battery.
- Two central, in-line reading windows . . . single row of digits plus a scale reading.
- Standard Cell adjustment for long term changes in voltage.
- Slidewire overlap . . . eliminates dial-switch operation for small voltage changes.

SPECIFICATIONS, GENERAL

High Range
Range: 0 to 1110 mV
Measuring Dials: mV Dial 10 x 100 mV; *Slidewire:* 0 to 110 mV, two-turn 27.5" long. Smallest division 200 uV.
Resolution: High Range 50 uV; *Low range:* 5 uV
Key: One single-pole, single-throw detector key with lock-down position.

Low Range
Range: 0 to 111 mV
Measuring Dials: mV Dial 10 x 10 mV; *Slidewire:* 0 to 11 mV, two-turn 27.5" long. Smallest division 20 uV.

Limits of Error *High Range:* ± (0.05% of reading +150 uV) *Low Range:* ± (0.05% of reading +15 uV)

Max External Resistance *High Range:* 200 K ohms approx.; *Low Range:* 10 K ohms approx.

Function Switch 7-position switch to provide the following internal connections: (1) 'OFF"; (2) "OUTPUT X 1"; (3) "MEASURE X 1"; (4) "STANDARDIZE"; (5) "MEASURE X 10"; (6) "OUTPUT X 10"; (7) "OFF"

Detector Solid-state, null detector. *Sensitivity:* 50 uV per division. *Noise:* 10 uV peak to peak. *Input Resistance:* 10 K ohms. *Common Mode Rejection:* 132 dB. *Zero Adjustment:* ±15 mV

Zero Stability: Time, 10 uV/hr, non-cumulative
Temp, 10 uV/°C
Source Resistance, 10 uV for 1000 ohm change

Response Time 1 second

Power Supply ±4.05 V at 1 mA. Two self-contained mercury batteries.

Battery Life Approx 1000 hours operation.

Batteries Self-contained; one 1.5 V for measuring circuit

Rheostat 3-turn rheostat for adjustment of battery current

Std Cell Adj Recessed, slotted shaft for internal slidewire provides adjustment for any standard cell voltage from 1.0170 to 1.0200 V.

Case Metal, with vinyl finish, handle and removable lid. Operating directions carried in the lid of case.

Dims 12-11/32" x 8-29/32" x 7-9/16" (314 x 226 x 192 mm)

Weight Net, approx 13 lb (6 kg); shipping, approx 17 lb (7.7 kg)

ACCESSORIES, OPTIONAL, FOR 8691-2

124179	Cleaner-Lubricant for Slidewire
4385	Shunt Box, Bench Type (see 10.7-1-3)
7592	Volt Box, Bench Type (see 10.7-1-3)
9912	Run-Up Box, Bench Type (see 10.7-1-3)

REPLACEMENT PARTS

324050	Solid-State Null Detector Kit to replace the pointer galvanometer in earlier potentiometers. Results in increased sensitivity and permits use of higher external resistances. For specs, see 10.7-3-9.

OPTIONS FOR 8691-2

Suffix B L&N Report of Calibration. Using corrections shown on these reports, the limits of error at 25°C are ± (0.02% +10 uV) for "X 1"; ± (0.02% +100 uV) for "X 10".

NOTE: For applications where mercury is undesirable, the standard cell can be encapsulated in epoxy resin. Specify 130080 (includes mounting bracket). The 056056 Mercury Batteries which power the detector can be replaced with Eveready 333 (4.5 V) carbon-zinc batteries, or equivalent.

8692-2-□ AND 8693-2-□-□ PORTABLE POTENTIOMETERS

For general plant and laboratory temperature measurements or checking similar potentiometers, recorders, and controllers.

Add range suffix number to catalog number: see following pages for standard ranges. For special IPTS-68 Ranges and all IPTS-48 Ranges, consult EIC.

FEATURES

- Self-contained built-in solid-state null detector, standard cell and battery. Central window for scale reading.
- Direct Reading in °F or °C for specified noble-metal or base-metal thermocouples. For 8693-2: Two ranges, any combination; Different or same type of couple; Automatic reference junction compensation on all temperature ranges; Millivolt standard ranges.
- Simplified Range Change. Use only a screwdriver, no soldering required.
- Convenient to use as a source of calibrated EMF for checking other instruments.

SPECIFICATIONS — 8692-2-□ PORTABLE POTENTIOMETER — SINGLE RANGE

Range Any standard *single* range as specified (see following pages)

Smallest Scale Div *See Range table, following pages.*

Resolution 1/2 to 1/5 scale division

Limit of Error ±0.2% of range span

Max External Resistance 10 K ohms approx for all standard ranges
1 K ohms approx for 5 mV special ranges

Measuring Dial one scale, 27.5" (approx 70 cm) long, mounted on two-turn slidewire

Ref Jct Compensator Automatic on all temperature ranges

Function Switch 5-position switch to provide the following internal instrument connections: (1) "OFF"; (2) "OUTPUT"; (3) "STANDARDIZE"; (4) "MEASURE"; (5) "OFF"

Solid-State, Null Detector *Sensitivity:* 50 uV/div; *Noise:* 10 uV peak to peak; *Input Resistance:* 10,000 ohms; *Common Mode Rejection:* 132 dB; *Zero Adjustment Range:* ±15 mV; *Zero Stability Time:* 10 uV/hr noncumulative; *Temp:* 10 uV/°C; *Source Resistance:* 10 uV for 1000 ohm change; *Response Time:* 1 second.

Batteries ±4.05 V at 1 mA. Two self-contained mercury batteries; Battery Life: Approx 1000 hrs operation.

Battery Rheostat Three-turn rheostat for adjustment of battery current

Key One single-pole, single-throw detector key with lock-down position

Battery Self-contained; one 1-1/2 V for measuring circuit, two 4.05 V for detector

Case Metal with vinyl finish, handle and removable lid. Operating directions carried in lid of case

Dims 12-11/32 x 8-29/32 x 7-9/16" (314 x 226 x 192 mm)

Weight Net, approx 13 lb (6 kg); shipping, approx 17 lb (7.7 kg)

8693-2-□-□ PORTABLE POTENTIOMETER DOUBLE RANGE

Same as 8692-2-□ except:

Range Any *two* standard ranges as specified. See following pages

Smallest Scale Div SEe Range table, following pages

Measuring Dial *Two* scales 27.5" (approx 70 cm) long, mounted on two-turn slidewire

Function Switch 8-Position switch to provide the following internal instrument connections: (1) "OFF"; (2) "OUTPUT A"; (3) "MEASURE A "; (4) "STANDARDIZE A"; (5) "STANDARDIZE B"; (6) "MEASURE B"; (7) "OUTPUT B"; (8) "OFF"

OPTIONAL ACCESSORIES

—	Thermocouple
—	Scale, Circuit Panel, (and Binding Posts if required) for range-change versatility
124179	Cleaner-Lubricant for Slidewire

REPLACEMENT PARTS

324050	Solid-State Null Detector Kit to replace the pointer galvanometer in earlier potentiometers. Results in increased sensitivity and permits use of higher external resistances. For specs see 10.7-1-9.

NOTE: For applications where mercury is undesirable, the standard cell can be encapsulated in epoxy resin. Specify 130080 (includes mounting bracket). The 056056 Mercury Batteries which power the detector can be replaced with Eveready 333 (4.5 V) carbon-zinc batteries, or equivalent.

STANDARD RANGES FOR 8692-2-☐ and 8693-2-☐-☐ (IPTS-68)

TYPE OF THERMOCOUPLE	RANGE	SMALLEST SCALE DIVISION	SUFFIX NUMBER ★
Type J, IPTS–68 (Iron—Constantan)	0 to 300 F	0.5 F	**501**
	-100 to +500 F	1.0 F	**502**
	0 to 1000 F	2.0 F	**503**
	400 to 1200 F	2.0 F	**504**
	0 to 1600 F	5.0 F	**505**
	0 to 2000 F	5.0 F	**506**
	900 to 2000 F	2.0 F	**507**
	-55 to +105 C	0.5 C	**509**
	0 to 200 C	0.5 C	**510**
	-100 to +400 C	1.0 C	**511**
	0 to 500 C	1.0 C	**512**
	0 to 800 C	2.0 C	**508**
	0 to 1100 C	2.0 C	**514**
Type K, IPTS–68 (Chromel—Alumel)	0 to 700 F	2.0 F	**515**
	0 to 1200 F	2.0 F	**516**
	0 to 2000 F	5.0 F	**517**
	0 to 2500 F	5.0 F	**518**
	1000 to 2500 F	5.0 F	**519**
	0 to 600 C	1.0 C	**521**
	0 to 1200 C	2.0 C	**522**
	500 to 1200 C	2.0 C	**523**
Type S, IPTS–68 (Platinum, 10% Rhodium—Platinum)	0 to 3200 F	5.0 F	**526**
	2000 to 3200 F	2.0 F	**527**
	0 to 1600 C	5.0 C	**532**
Type R, IPTS–68 (Platinum, 13% Rhodium—Platinum)	0 to 3200 F	5.0 F	**535**
Type T, IPTS–68 (Copper—Constantan)	-340 to +230 F	-340 to -100 F | 2.0 F	**540**
		-100 to +230 F | 1.0 F	
	-100 to +400 F	1.0 F	**541**
	0 to 650 F	2.0 F	**542**
	-200 to +150 C	-200 to -150 C | 2.0 C	**543**
		-150 to + 50 C | 1.0 C	
		50 to 150 C | 0.5 C	
	-100 to +300 C	1.0 C	**544**
	0 to 400 C	1.0 C	**545**
Millivolts	-5 to 0 to +5	0.02	**546**
	0 to 10	0.02	**547**
	0 to 25	0.05	**548**
	0 to 50	0.10	**549**
No reference-junction compensation provided on millivolt ranges			

★ To specify, add suffix number(s) to catalog number 8692 or 8693. For the 8693, the range number listed as the first suffix following the catalog number is the "A" or top range on the scale while the range number listed as the second suffix is the "B" or bottom range on the scale. Thus, to obtain the desired relationship of ranges one need only write the complete catalog number accordingly.

STANDARD RANGE CHANGE PARTS FOR 8692, 8693 SERIES PORTABLE & PANEL-MOUNTED POTENTIOMETERS

The parts that must be replaced are:

(1) Scale . . . . Select appropriate suffix number from standard range list and add to base scale and circuit panel numbers given
(2) Circuit Panel below. Changing both ranges on 8693-2 requires two scales and two circuit panels with appropriate suffix numbers to denote desired ranges.

(3) Binding Post Studs . . . . If required. Check existing range(s)

(4) Extension Leadwire . . . . For panel-mounted potentiometers only. Extension leadwires (or copper wire) connecting each binding post to terminal strip in rear must be replaced if range(s) is/are changed.

(a) from one type couple to another
(b) from MV to TC range
(c) from TC to MV range

ORDER THE FOLLOWING PARTS AS REQUIRED:

189☐☐☐ Scale
605☐☐☐ Circuit Panel

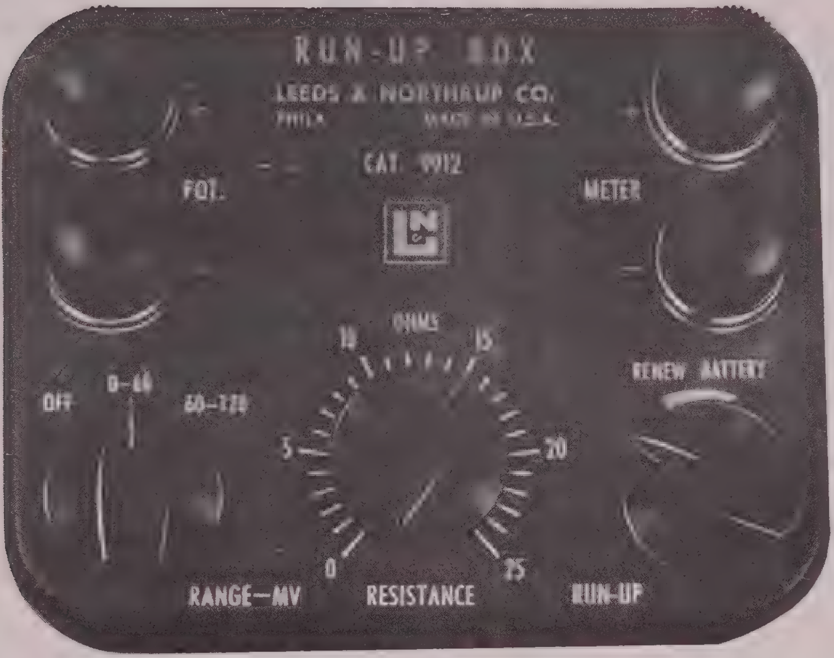
THERMOCOUPLE/MILLIVOLTS	POSITIVE STUD		NEGATIVE STUD		EXTENSION LEADWIRE FOR PANEL-MOUNTED POT.	
	MATERIAL	PART NO.	MATERIAL	PART NO.	POSITIVE	NEGATIVE
Type J-68	Iron	061469	Constantan	061468	237332	237336
Type K-68	Copper	061467	Constantan	061468	237335	237336
Type S-68	Copper	061467	Copper	061467	237333	237334
Type R-68	Copper	061467	Copper	061467	237333	237334
Type T-68	Copper	061467	Constantan	061468	237335	237336
Millivolts	Copper	061467	Copper	061467	237337	237338

NONSTANDARD RANGE CHANGE PARTS FOR 8692 AND 8693 SERIES

For availability, price and delivery on special IPTS 68 Ranges and all IPTS 48 Ranges, Consult EIC.

T

9912 RUN-UP BOX


RUN-UP BOX
LEEDS & NORTHRUP CO.
PHILA. MADE IN U.S.A.
CAT. 9912
POT.
METER
OHMS
10
15
5
20
0
25
RENEW BATTERY
OFF
0-60
60-120
RANGE—MV
RESISTANCE
RUN-UP

ADVANTAGES

- Broadens potentiometer applications to checking and calibrating — Instruments which require current flow for operation (e.g., deflection types)—Low range null balance instruments requiring low resistance mV sources — Adjustable series resistance simulates TC and leadwire resistance
- Low-resistance recorder checks — eliminates reduced recorder sensitivity and excessive deadband
- Standard level amplifier checks — eliminates "loading" effect of voltage divider on potentiometer
- Easy to operate
- Mounting versatility — for bench use, panel-mounting, or mounted on side or in lid of potentiometer

FEATURES

- Self-contained
- Convenient range selection — 0 to 60, 60 to 120 mV and OFF
- Adjustable series resistance — easily set to external resistance value required by instrument being checked
- Run-Up knob — dual potentiometer for Course and Fine millivoltage output adjustments with Renew Battery indicator
- Panel-Mounted Run-Up Box includes convenient Meter connections on front and rear panels

9912 PORTABLE RUN-UP BOX

A battery operated low impedance source of an uncalibrated, variable dc millivoltage supplied through a calibrated, variable resistance.

APPLICATION

Used in conjunction with a potentiometer for checking and calibrating instruments which require current flow for operation, such as deflection-type millivolt indicators. Also used for dynamic checking of low millivoltage range Speedomax Recorders or similar null-balance instruments which require low impedance sources.

SPECIFICATIONS FOR 9912

Range 0 to 60 and 60 to 120 mV, adjustable to better than ±0.02 mV.

Output Series Resistance Adjustable from 0 to 25 ohms, to within ±0.5 ohms.

Battery 1-1/2 V, Type D. Current drain approx. 4 mA, operating life 500 hours minimum, shelf life approx. 1 year.

Function Switch 3-Position switch for OFF, 0 to 60 and 60 to 120 positions.

Output mV Adj. RUN-UP knob: dual potentiometer provides coarse and fine adjustment of the mV output of the Run-Up Box.

ADDITIONAL SPECIFICATIONS REQUIRED BY CATALOG NUMBER

9912 PORTABLE RUN-UP BOX

Terminals Two pair. For potentiometer and meter

Connections Two gold-plated straps for connections to potentiometer EMF posts

Case Drawn aluminum box and lid

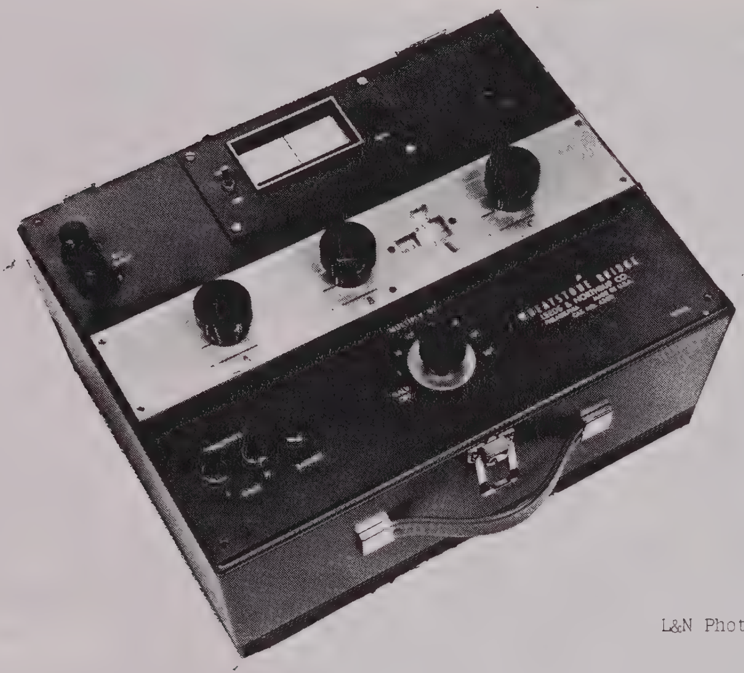
Dims. 5-1/8 x 3-7/8 x 2-5/8" (130 x 98.4 x 66.7 mm)

Weight Net, approx. 1-1/2 lb (0.68 kg); shipping, approx. 2-1/2 lb (1.13 kg)

OPTIONAL MOUNTING OF 9912

8686-R	Portable Millivolt Potentiometer with Run-Up Box (see Sect. 10.1-1-1).
8690-R	Portable Millivolt Potentiometer with Run-Up Box (see Sect. 10.1-1-2).

4289-2 AND 4289-3 PRECISION PORTABLE DC WHEATSTONE BRIDGE



L&N Photo No. 46581-2

ADVANTAGES

- Portable — ready to use — easy to operate
- Direct reading
- Shielding — permits use of null detector for greater sensitivity
- Bridge method — eliminates errors inherent in conventional type ohmmeter
- Resolution of 0.0001 ohm on low range

FEATURES

- Central reading window — single row of digits plus a scale reading
- Metal case and top plate — electrostatic shielding
- Additional binding posts for external null detector

- 4289-2 . . . Built-in solid-state null detector — offers continuously adjustable sensitivity (0.5 uV/division maximum) and adjustable zero
- 4289-3 . . . Built-in solid-state null detector — sensitivity 5 uV/division

PRECISION DC WHEATSTONE BRIDGE

4289-2 *Type::* Portable, self-contained; *DC Null Detector:* 2437-2-10 Electronic Null Detector continuously adjustable sensitivity, high impedance (see 10.7-1-3); *Power Supply:* Batteries (see 10.8-1-1)
4289-3 *Type:* Portable, self-contained; *DC Null Detector:* Solid-State Null Detector similar to 324190 (see 10.7-1-3); *Power Supply:* Batteries (see 10.8-1-1).

APPLICATION

Used in plant or laboratory for measuring the resistance of all sorts of electrical components and devices, such as meters, instruments, components of electronic equipment, motor and transformer windings, and components of communication, refrigeration, and heating equipment.

NOTE: CAT 4289 Wheatstone Bridge
with galvanometer type detector
was withdrawn from sale in OCT. 1989

SPECIFICATIONS 4289-2 AND 4289-3

Range 1 ohm to 11.01 megohms in 7 ranges

Limit of Error ±0.05% of reading

Rheostat Arm Two decades plus a slidewire, covering a range in resistance from 100 to 1101 ohms. First decade consists of 10 steps of 100 ohms/step (dial marked 1 to 10). Second decade consists of 9 steps of 10 ohms/step (dial marked 0 to 9). Slidewire is shunted to about 11 ohms.

Ratio Arms Seven ratios, switch selected. Ratios are nominally 100: 10,000; 100: 1000; 1000: 1000; 1000: 100; 10,000: 100; 100 K: 100; and 1 megohm: 100.

An auxiliary slidewire is connected between the two ratio arms to compensate for the effect of the main slidewire on the ratio arms.

Readout All dial readings, except decimal multipliers, appear in a central readout window and are displayed as a series of digits plus a scale reading.

Scale 220 divisions

Smallest Scale Division

X1: 0.0005 ohms
X10: 0.005 ohms
$X10^2$: 0.05 ohms
$X10^3$: 0.5 ohms
$X10^4$: 5.0 ohms
$X10^5$: 50.0 ohms
$X10^6$: 500 ohms

Resolution

X1: 0.0001 ohms
X10: 0.001 ohms
$X10^2$: 0.01 ohms
$X10^3$: 0.1 ohms
$X10^4$: 1.0 ohms
$X10^5$: 10.0 ohms
$X10^6$: 100 ohms

Range Switch 8-Position switch marked "Multiply By". Switch positions are GALV OFF, X1, X10, $X10^2$, $X10^3$, $X10^4$, $X10^5$, and $X10^6$. Switch selects bridge ratios, turns galvanometer lamp on and off, and when in GALV OFF position, shorts galvanometer terminals for protection during shipment.

Power Supply One 22.5 V battery (6 V for the 4289-2) supplies current for bridge circuit. *Maximum current drawn:* 10 mA (2.7 mA for 4289-2); *Estimated life:* three months in normal service. Two self-contained batteries for detector. *Battery life for 4289-3:* 2000 hours operation or 10 months whichever is less.

Keys Low and high galvanometer sensitivity selection and one for battery. Lock-down type.

Binding Posts Four. Two for connections to unknown resistance, and two for connections to external null detector when greater sensitivity of measurement is required.

Case Gray metal case with slip-hinged removable lid and carrying handle. Directions book conveniently stored in lid.

Dims 14-1/4" x 11-1/2" x 7-1/2" (362 x 292 x 191 mm)

Weight Net, approx 21 lb (9.5 kg); shipping, approx 28 lb (12.7 kg)

OPTIONS, 4289 SERIES

Suffix B L&N Report of Calibration. Using corrections shown on these reports, the limit of error at 25° C is ±0.02% of reading.

OPTIONAL ACCESSORIES FOR 4289 SERIES

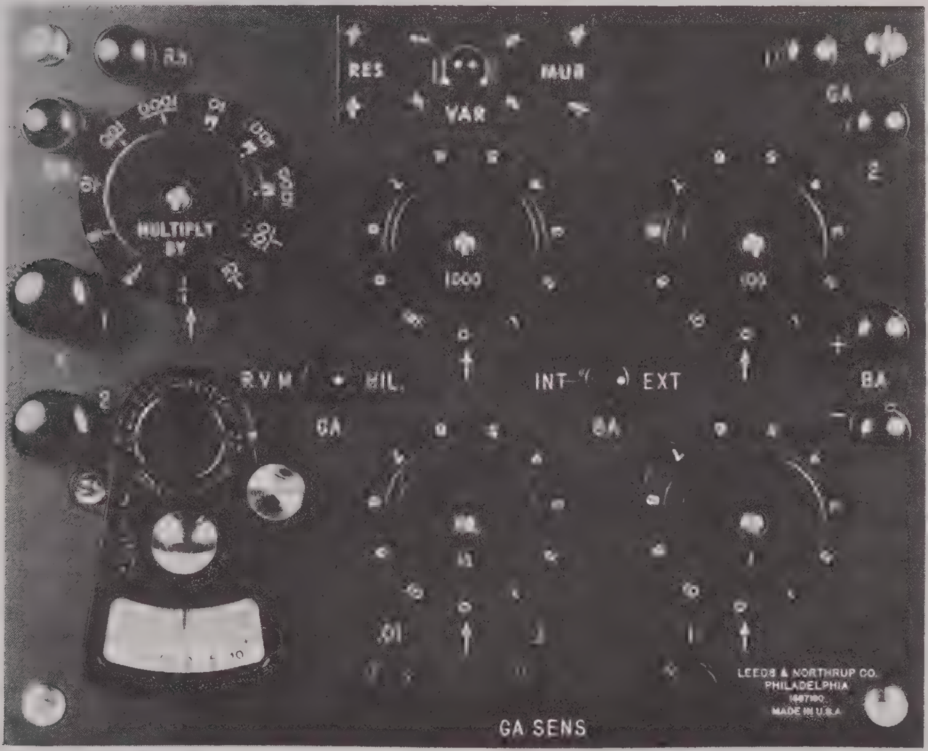
124179	Cleaner-Lubricant for Slidewire

For Portables

9828	DC Null Detector. *For greater sensitivity measurement requirements. Shielded input cable assembly is supplied with detector for connections to binding posts of bridge.*
2437-0-☐	Electronic Null Detector, Component Type for 4289
324190	Kit, Solid-State Null Detector, designed to replace the light beam galvanometer in the 4289 Wheatstone Bridge.

Multiplier	Range Ohms	Resolution ppm/Div (1.5 mm)	Sensitivity Per Division 4289-2 1 Div = 1.6 mm	Sensitivity Per Division 4289-3 1 Div = 1.5 mm
1	1 - 10	500 - 50	187 - 26 ppm	500 - 74 ppm
10	10 - 100	500 - 50	22 - 5.3 ppm	63 - 14 ppm
10^2	100 - 1000	500 - 50	3.8 - 1.1 ppm	10 - 3 ppm
10^3	1 K - 10 K	500 - 50	5.3 - 3.4 ppm	14 - 9 ppm
10^4	10 K - 100 K	500 - 50	12 - 10 ppm	32 - 27 ppm
10^5	100 K - 1 M	500 - 50	0.0086%	0.023%
10^6	1 M - 10 M	500 - 50	0.086%	0.23%

5430-AM-1 TYPE U PORTABLE TEST SET


RES
VAR
MUR
GA
MULTIPLY BY
1000
100
R.V.M.
HIL.
INT
EXT
GA
BA
BA
.01
GA SENS
LEEDS & NORTHRUP CO.
PHILADELPHIA
MADE IN U.S.A.

ADVANTAGES

- Rugged portable, convenient in field for locating faults in communication circuits.
- Design based on requirements of telephone engineers.
- Gloves may be worn while operating — easy to read.
- Note Book, FAULT LOCATION IN CABLES, supplied for full explanation on use of instrument.
- May be used as a 4-dial adjustable resistance.

FEATURES

- Self contained — pointer galvanometer and batteries.
- Knurled knobs for easy manipulation.
- Single, lever type key for Resistance-Varley-Murray (and Hilborn) connections.
- Single-dial ratio unit with multipliers convenient for Murray and Varley Loop Test.
- Additional binding posts for optional use of external galvanometer and batteries.

5430-AM-1 TYPE U TEST SET

A portable Wheatstone bridge for locating line and cable faults in signal communication circuits.

APPLICATION

Design based on requirements set up by telephone engineers. For identifying faulty wires in a cable; locating grounds, shorts and crosses by the Murray, Varley, Hilborn and other loop tests; locating opens by capacitance methods; and measuring conductor resistances.

To measure resistance above 40,000 ohms, an external galvanometer of greater sensitivity and/or an external battery of higher voltage are normally required. In measuring high resistances, the bridge accuracy may be adversely affected by leakage due to humidity and possible contamination. Should the battery voltage exceed 45 volts, an external resistance of 40 ohms for each volt over 45, up to 200 volts, must be added in series with battery. For measurements below 1 ohm, allowance must be made for the resistance of the test leads and contacts.

SPECIFICATIONS

Ratio Arms Enclosed dial switch. Multiplying values of 1/1000, 1/100, 1/10, 1/9, 1/4, 1/1, 10/1, 100/1, for resistance measurements and for Varley Loop tests. Also settings of M1000, M100, and M10 for ratios in Murray Loop Tests.

Rheostat Enclosed dial switches. Four decades, 10 (1 + 10 + 100) +9 x 1000 + infinity.

Limit of Error Overall bridge accuracy; ± (0.15% +0.01 ohm). Of ratios: ±0.05%. In rheostat arm: resistance change from zero setting of dials equals dial setting ± (0.1% +0.01 ohm).

Sensitivity One microampere/scale division. Built-in pointer-type galvanometer and batteries provide sensitivity adequate to balance the bridge within the guaranteed limit of error when measuring resistances from 1 to 40,000 ohms. To measure higher resistances, an external galvanometer of greater sensitivity and/or an external battery of higher voltage is required (up to 200 V dc).

Current Rating Of 4-dial rheostat when used separately, determined by highest decade in use. Decade: 1, 10, 100, and 1000 ohm. Ampere: 0.7, 0.2, 0.07, 0.02.

Batteries Three Type D flashlight batteries, supplying 4.5 volts, housed in separate leakproof compartment with molded-in terminals.

Keys Battery: lockdown key for internal or external battery connections. Galvanometer: 3 keys provide sensitivities of 0.01, 0.1, and 1; phased so that the battery circuit is energized before the galvanometer circuit.
Lockdown key marked RVM and HIL. In the HIL position, Hilborn Loop Test may be made. Internal galvanometer connected to binding post GA 1, lever switch in MUR position.

Test Selection Single lever-type (toggle switch) selection. Marked RES, VSR, MUR; for resistance, Varley, and Murray connections. MUR also used for Hilborn Loop Test.

Binding Posts Eight. For external galvanometer and battery, ground, unknown resistance. An extra binding post, RH, permits the rheostat to be used independently as a four dial adjustable resistance.

Case Metal, with slip-hinged, removable lid, plastic carrying handle, and bumpers.

Case Dims 8-3/8″ x 6-7/8″ x 6-3/8″ (213 x 175 x 162 mm)

Top Plate Dims 8-1/8″ x 6-5/8″ x 3/8″ (206 x 168 x 9.5 mm)

Weight Net, approx 10 lb (4.5 kg); shipping, approx 14 lb (6.4 kg)

4287-2 AND 4287-3 PRECISION PORTABLE DC KELVIN BRIDGES

A
B
KELVIN BRIDGE
LEEDS & NORTHRUP CO.

4287-2 DC KELVIN BRIDGES *shown, L&N Photo No. 46581-1*

ADVANTAGES

- Portable, ready to use, direct reading
- Eliminates errors of lead and contact resistance
- Lower ranges and higher accuracies — beyond scope of conventional deflection meter
- Shielding — permits use of null detector for greater sensitivity
- Provision for use of external standards, range extension and calibration
- High accuracy, from ±0.03% to ±0.05% of reading, with L&N Report of Calibration: ±0.02%
- High resolution, 0.01 uohm on low (100 uohms to 1101 uohms) range

FEATURES

- Central reading window; single row of digits plus a scale reading
- Four terminal measurements
- Metal case and top plate, electrostatic shielding
- Receptacle for male plug for external null-detector
- Additional binding posts for external standards and power supply
- 4287-2 . . . Build-in solid-state null detector, offers continuously adjustable sensitivity (0.5 uV/division maximum) and adjustable zero
- 4287-3 . . . Built-in solid-state null detector, sensitivity 5 uV/division

PRECISION DC KELVIN BRIDGES

4287-2 *Type:* Portable, self-contained; *DC Null Detectors:* 2437-2-10 Electronic Null Detector continuously adjustable sensitivity high impedance (see 10.7-1-3); *Power Supply:* Batteries (see 10.8-1-1)
4287-3 *Type:* Portable, self-contained; *DC Null Detectors:* Solid-state null detector similar to 324190 (see 10.7-1-3); *Power Supply:* Batteries (see 10.8-1-1)

APPLICATION

For low resistance measurements which are essentially independent of lead and contact resistance: precision resistors; switch and relay contacts; leads, terminals, and connections; motor, generator, and transformer windings; brushes and commutators, etc. For wires and rods, see Optional Accessories for 4287 Series.

NOTE: CAT 4287 Kelvin Bridge with galvanometer type detector was withdrawn from sale in OCT 1989

SPECIFICATIONS FOR 4287-2 AND 4287-3

Range 0.0001 to 110.1 ohms in six ranges

Limit of Error ±0.05% of reading. Improves to ±0.03% as the "A" dial is switched from the 1 to the 10 position.

Ratio Arms One arm fixed at 10,000 ohms; the other consists of 2 decades varying from 100 to 1000 ohms (marked 1 to 10) and 0 to 90 ohms (marked 0 to 0.9), plus a slidewire adjustable from 0 to 11 ohms (approx).

Standard Arm Six standard resistors of 0.01, 0.1, 1, 10, 100, 1000 ohms; switched as four-terminal elements.

Readout All dial readings, except decimal multipliers, appear in a central readout window and are displayed as a series of digits plus a scale interpolation.

Scale 220 divisions

Smallest Scale Division

$X10^{-4}$: 0.05 uohm
$X10^{-3}$: 0.5 uohm
$X10^{-2}$: 5.0 uohms
$X10^{-1}$: 50 uohms
X1: 500 uohms
X10: 0.005 ohm

Resolution

$X10^{-4}$: 0.01 uohm
$X10^{-3}$: 0.1 uohm
$X10^{-2}$: 1.0 uohm
$X10^{-1}$: 10 uohms
X1: 100 uohms
X10: 0.001 ohm

Range Switch Eight positions with steps of GALV OFF, 10^{-4}, 10^{-3}, 10^{-2}, 10^{-1}, 1, 10, and EXT STD x 10

Power Supply Battery (1.5 V) supplies current to bridge circuit. Two self-contained batteries for detector.

Keys Low and high galvanometer sensitivity selection and one for battery.

Binding Posts Eight; four for connection to the unknown resistance and four to permit substitution of external standards for internal.

External Detector and Power Supply Provision is made for using external null detector, if greater sensitivity is required. Also, circuit is arranged so that external battery or power supply may be substituted for internal battery.

Case Gray metal case with handle and slip-hinged removable lid.

Dims 14-1/4" x 11-1/2" x 7-1/2" (368 x 292 x 191 mm)

Weight Net, approx 23-1/2 lb (10.6 kg); shipping, approx 29 lb (13 kg)

OPTIONAL ACCESSORIES FOR 4287 SERIES

External resistors for range extension (see Section 10-3-2 for complete specs) may be used in either of three connection arrangements:

(1) Using internal power supply and internal switching
(2) Using external power supply and internal switching
(3) Using external power supply and external yoke

4333	Secondary Standard Resistor, 0.001 ohm, 4-terminal
124179	Slidewire Cleaner and Lubricant

4308 Current and Potential Clamps

Set of two pairs for making current and potential connections to wire or rod samples approx. 1/8" to 3/4" dia. Net Weight approx. 4 lb; Shipping Weight approx. 7 lb.

For resistance measurements where length of wire or rod to be measured must be accurately determined, as in conductivity measurements. The clamps are mounted in pairs, one current and one potential clamp attached to the same base comprising each unit of the pair. When the samples to be measured are always of the same length, the bases of the two units may be fastened to a common base to keep them at the proper distance between potential points. When the clamps have been adjusted for a sample of a given diameter, a quick-acting spring contact device in each clamp permits insertion of other samples of approximately the same diameter without disturbing the adjustment of the clamp screw.

For Portables

4308	Current and Potential Clamps. For measuring resistance of wires and rods 1/8" to 3/4" in diameter
9828	DC Null Detector. For greater sensitivity requirements
2437-2-☐	Electronic Null Detector, component type for 4287
324190	Kit, Solid-State Null Detector. Designed to replace light beam galvanometer in the 4287 Kelvin Bridge.

Multiplier	Range Ohms	Resolution ppm/Div 1 Div = 1.5 mm	Sensitivity Per Division		
				4287-2 1 Div = 1.6 mm	4287-3 1 Div = 1.5 mm
10	10 - 100	500 - 50		33 - 4 ppm	330 - 55 ppm
1	1 - 10	500 - 50		33 - 4 ppm	330 - 55 ppm
10^{-1}	0.1 - 1	500 - 50		33 - 4 ppm	330 - 55 ppm
10^{-2}	000.01 - 0.1	500 - 50		37 - 4.4 ppm	370 - 60 ppm
10^{-3}	0.001 - 0.01	500 - 50		67 - 8 ppm	670 - 104 ppm
10^{-4}	0.0001 - 0.001	500 - 50		370 - 41 ppm	0.37 - 0.056%
Ext Std 10^{-5}	10 - 100	500 - 50		0.33 - 0.037%	3.33 - 0.51%

8064 SERIES PORTABLE RESISTANCE THERMOMETER BRIDGES

A
B
C
BRIDGE
GALV OFF
RESISTANCE THERMOMETER BRIDGE
LEEDS & NORTHRUP CO.

FEATURES

- Central reading window . . . single row of digits plus a scale reading
- Multiple thermohm measurements using optional external rotary selector switch
- May be used with either three- or four-lead resistance thermometers
- Metal case and top plate . . . electrostatic shielding

- 8064-2★ . . . Built-in electronic null detector offers continuously adjustable sensitivity (0.5 uV/div max) and adjustable zero
- 8064-3 . . . Built-in solid state null detector. Sensitivity 5 uV/division
- "-A□" types offer extended range

APPLICATION

A Wheatstone bridge for precise measurements of temperature or temperature difference using three or four-lead copper, nickel or platinum resistance thermometers. Used in aircraft, power, heating, ventilating and air-conditioning industries. Equally suitable for environmental testing, drying and baking, injection molding, plating and other applications where high sensitivity and a virtually permanent calibration are needed.

Cat. No. 8064-2, -A2 *Type:* Portable, self-contained. *DC Null Detector:* 2437-2-10 Electronic Null Detector continuously adjustable sensitivity high impedance (see 10.7-1-3). *Power Supply:* Batteries (see 10.8-1-1).
Cat. No. 8064-3, -A3 *Type:* Portable, self-contained. *DC Null Detector:* Solid-State Null Detector similar to 324190. *Power Supply:* Batteries (see 10.8-1-1).

NOTE CAT 8064 thermometer Bridge with
galvanometer type detector
was withdrawn in OCT 1989

★ *For photo of detector as used in 8686-2 Potentiometer, see 10.7-1-3.*

SPECIFICATIONS, GENERAL, FOR 8064-2, 8064-3

Range 0 to 160.1 ohms

Limit of Error ±0.05% of reading or ±0.005 ohms, whichever is larger

Rheostat Arm Two decades plus slidewire, covering range in resistance of 0 to 160.1 ohms. First decade consists of 15 steps of 10 ohms per step (dial marked 0 to 15). Second decade consists of 9 steps, 1 ohm per step (dial marked 0 to 9). Slidewire is shunted to 1.10 ohms.

Smallest Scale Div 0.005 ohm (220 slidewire divisions)

Resolution 0.001 ohm (1/5 scale division)

Readout All dial readings appear in a central readout window and are displayed as a series of digits plus a scale reading.

Ratio Arms 130 ohms, nominal

Power Supply Battery (1.5 V) supplies current for bridge circuit, maximum current drawn: 23 mA. Two self-contained batteries for detector. Battery life: 2000 hrs operation or 10 months whichever is less.

Binding Posts Four binding posts are available for connecting either three or four-lead resistance thermometers to bridge; marked A, B, B_1, and C.

Keys One detector and one battery key; both are lock-down variety.

Function Switch Four-position function switch, marked DET OFF, BRIDGE CURRENT-LOW, BRIDGE CURRENT-HIGH, and DET OFF.

Case Gray metal with handle and removable lid. Operating directions and Standard Conversion Tables for L&N Thermohms are supplied in lid.

Dims 14-1/4" L x 11-1/2" W (including handle) 7-1/2" H (362 x 292 x 191 mm), including rubber bumpers and lid.

Weight Net, approx 20-1/2 lb (9.3 kg); shipping approx 26 lb (11.8 kg)

Function Switch Eleven position switch includes add-to-reading positions of 0, 100, 200, etc. to 900 (range extension), and off-position.

★ *Figures in parenthesis are the bridge currents when measuring the corresponding resistance. Note that only half this amount flows through the thermometer being measured.*

SPECIFICATIONS FOR DC RESISTANCE THERMOMETER BRIDGES (cont)

OPTIONS FOR 8064 SERIES

Suffix B L&N Report of Calibration. Using corrections shown on these reports, the limits of error at 25°C are: ±0.03% or 0.003 ohm, whichever is larger.

ACCESSORIES FOR 8064 SERIES

—	Switch, 3-pole, double-throw for 4-lead resistance thermometer. *(Submit EIC for information on particular application)*
8249-☐	Enclosed Rotary Type Selector Switch (10, 12 or 16 points) for multiple thermohm measurements
124179	Cleaner-Lubricant for Slidewire
2437-2-☐	DC Electronic Null Detector; component type to replace galvanometer in 8064, 8064-A (see 10.7-1-3)
324190	Kit, Solid State Null Detector. Designed to replace the 062103 Light Beam Galvanometer in the 8064.

Range Ohms	Resolution ppm/Div (1.5 mm)	Sensitivity Per Division		
			8064-2 1 Div = 1.6 mm	8064-3 1 Div = 1.5 mm
1 (23 mA)	5000		44 ppm	440 ppm
160 (10 mA)	31		1.4 ppm	14 ppm
High Current★				
1 (1 mA)	5000 (0.5%)		0.1%	1%
160 (1 mA)	31		14 ppm	140 ppm
Low Current★				

8064-A2, 8064-A3

Specifications same as 8064, 8064-2 and 8064-3 respectively except:

Range Ohms	Resolution ppm/Div (1.5 mm)	Sensitivity Per Division		
			8064-A2 1 Div = 1.6 mm	8064-A3 1 Div = 1.5 mm
160	31		1.4 ppm	14 ppm
1060	5		3.4 ppm	34 ppm

4866 PORTABLE BRIDGE FOR ELECTROLYTIC CONDUCTIVITY

ADVANTAGES

- Measures directly specific resistance or specific conductance (80 to 10,000,000 ohms-cm and 0.012 to 0.000,000 1 mho/cm), for use with 0.1 cell constant).
- Portable, line-operated – permits making measurements at the process
- Easy to operate and read
- A conductivity cell is the only accessory required

FEATURES

- Centrally located scale, 10^N multiplier
- Manual double-dial compensator – electrolyte temperatures from 5 C to 45 C (referred to 25 C), cell constants 0.07 to 0.12 cm^{-1}
- Self-contained ac pointer galvanometer
- Sturdy wooden case with hinged lid and carrying handle

4866-60 PORTABLE CONDUCTIVITY RESISTIVITY BRIDGE

APPLICATION

A simple ac Wheatstone Bridge for general use in measuring the specific conductance and specific resistance of electrolytic solutions.

SPECIFICATIONS

Range, Specific Conductance 0.012 to 0.000,000 1 mho.

Range, Specific Resistance 80 to 10,000,000 ohms-cm

Limit of Error Of conductance scale, 0.3 percent of its 1 to 12 range; of compensators, 0.002 and 1 C respectively.

Compensators Two: one for conductivity cell constants, between 0.07 and 0.12; one for solution temperatures, between 5 and 45 C.

Detector AC pointer galvanometer; self-contained.

4866

Transformer Isolating transformer separates measuring circuit from direct connection to the power circuit.

Switch AC: ON, OFF.

Power Supply For operation on 120 volts, 60 Hz.

Case Wood, oak finish 13-3/4″ x 9-1/2″ x 6-1/2″ (346 x 241 x 165 mm). Has hinged lid and carrying handle.

Weight Net, approx. 17 lb (7.7 kg); shipping approx. 28 lb (12.7 kg).

DIRECTIONS 077936

ACCESSORY FOR 4866-60 BRIDGE

A B C D E
4905-01-44-000-7-000 Conductivity Cell,
See Section 2.2-1-2

01	0.1 Cell Constant
44	Platinum Electrode
000	No Auto Temp. Comp.
7	7 Ft. Leadwire
000	No Tagging

STANDARD CELLS

7311 EPPLEY STANDARD VOLTAGE REFERENCE

FEATURES

Saturated...permits full realization of precision potentiometer accuracy

Portable and shippable...may be used as a traveling standard for inter-laboratory comparisons

Constant temperature air bath regulated to ±0.01 C

High-resolution mercury thermometer...readable to 0.01 C

SPECIFICATIONS

Type	Eppley Model 125 Standard Voltage Reference
Consists of	Four Eppley 325 miniature shippable-type saturated standard cells mounted in a temperature controlled enclosure
Operating Temp.	Constant temperature air bath controls temperature at 28 C nominal to ±0.01 C. (saturated cells normally have a temperature coefficient of about -40 µV C at 20 C)
Regulation	Controlled by a mercury thermostat actuating a solid state switching network. A thermoswitch guard is provided to prevent cell damage in the event of failure of the main regulator.
Thermometer	Mercury thermometer located in top panel extends into cell chamber. Range: 27.8 C to 28.2 C in 0.02 degree graduations; readable to 0.01 C.
Well	Thermometer well will accommodate L&N 8163 Platinum Thermohm for precise checks of cell temperature
Voltage Stability	1 ppm
Input Voltage	115V., 60 or 50 Hz, with automatic changeover to 12V d-c standby (not supplied)
Power	Less than 8 watts consumed
Certificate	Eppley certificate is supplied, stating voltage of cells to nearest 1-microvolt, correct to 2-microvolts at time of calibration
Drift	It is expected that the rate of drift will not exceed 3-microvolts/year. The rate of drift will be somewhat less if the cells are hand-carried rather than shipped to the calibration facility
Case	Mahogany grained formica with carrying handle
Dimensions	13" L x 9" W x 10" H (330x229x254 mm)
Weight	Net, about 30 lb (13.6 kg)
Shipped	F.O.B. Newport, Rhode Island

OPTIONS

-B Suffix .... L&N Report of Calibration. *(For details, see "Recertification" below.)*

NBS Report of Calibration:

Report states voltages of cells to nearest 0.1 µV, the stated values accurate to 1 µV at time of calibration. NBS recommends new cells be shipped several times in first year to establish stability pattern.

Specify as separate item on order; note however, that it is preferable to have customer deal directly with NBS. If L&N to handle, refer to CALIBRATING SERVICES in Section 10.0-1-1, except voltage Reference will be shipped direct to customer from Bureau of Standards (will not first be returned to L&N).

REPAIRS, RECERTIFICATION, ETC.

DEFECTS OR REPAIRS . . . Refer to Eppley Laboratory, Inc., Newport, Rhode Island

RECERTIFICATION . . . . . . NBS: User should handle directly

L&N: Report of Calibration states traceability to NBS, and lists voltage of cells to nearest 1.0 µV with a maximum uncertainty of 2.0 µV

STANDARD CELLS

7308 EPPLEY UNSATURATED STANDARD CELL

A standard of emf used in high precision measurements for establishing a precise value of working current through the potentiometer's calibrated resistors and slidewire.

Emf	Upon delivery, within limits 1.01884 to 1.01964 volt.
Internal Resistance	Approximately 500 ohms.
Certificate (Eppley)	States emf to nearest 0.001% (10 ppm), the stated value certified to be correct within ±0.005% (50 ppm)
Case	Copper-lined, black, moulded plastic. Has binding posts marked to indicate polarity. 4-1/8" (L) x 4" (W) x 5-3/16" (H) **(105 x 102 x 132 mm)**
Weight	Net, about 2 lb **(0.9 kg); shipping, about 3 lb (1.4 kg)**

Unsaturated Cells are commonly used for potentiometric work. They are more portable than many saturated types and have much lower temperature coefficients. When new, they have an emf of about 1.0190 absolute volts. This tends to decrease about 100 µV (0.01%) per year, giving a useful life of about ten years. Unsaturated standard cells should not be exposed to temperatures below -4C or above +40C. Maximum drain, 10 µA for a short period of time.

THOMAS TYPE ONE OHM STANDARD — 4210-☐

Designed for use as a four-terminal primary standard of resistance in laboratories requiring extremely high precision.

ADVANTAGES

- Adaptation of resistor developed at NBS by Dr. J.L. Thomas (NBS Research Paper 1692)

FEATURES

- Hermetically sealed
- Resistance element bifilar wound without stress on insulated brass cylinder
- Specifically selected, thoroughly annealed bare manganin wire
- Brazed leads are brought out through metal-to-glass seals
- Includes Report of Value and Temperature Coefficient Report

SPECIFICATIONS

Resistance Adjusted to one absolute ohm between potential leads

Limit of Error Adjusted within 5 parts/million (0.0005%) of nominal value at 25°C

Stability Typically does not exceed 1 part/million/year under conditions of normal use

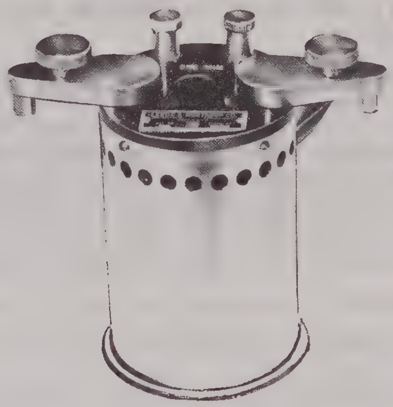
Current Rating 0.1 ampere in stirred oil

Connections Four-terminal, current/potential type. Resistance of current and potential leads, approx 0.0011 to 0.0013 ohm each.

Dims 7″ W x 6-1/2″ H x 3-3/4″ OD (178 x 165 x 95 mm)

Weight Net 3 lb (1.4 kg). Packaged for shipment 9.25 lb (4.2 kg)

Case (039768) Metal, gray enamel finish containing a foam polystyrene form to hold unit firmly in place



4210-B Report Include the following

L&N Report of value which states the measured value to 0.1 part/million (0.00001%) at 25°C, accurate to 0.5 part/million (0.00005%), and includes the alpha and beta values for the Rt equation. Also includes statement regarding the minor effect of changes in barometric pressure.

A computer-calculated tabulation of resistance change from 25°C for every 0.1°C between 18 and 30°C. The change is expressed in parts/million and is listed in the table to the nearest 0.1 ppm.

NOTE: It is not recommended that temperature coefficient data be requested from NBS. This data is supplied with the L&N report, and experience indicates that it does not change with time.

ACCESSORY

127287 Adjustable Mercury-Cup Stand

Data Sheet A5.1111 DS

4214-B RESISTANCE STANDARD, 10,000 OHM

DESCRIPTION

The 4214 has the characteristics of a highest quality standard suitable for the calibration of other high accuracy resistive devices. The terminal spacing and height are equal to the 4210 Thomas One-Ohm Standard permitting the standard to be used in existing oil bath fixtures. Although designed for use in an oil bath, the standard may be used with equal accuracy in air when mounted inside the thermally lagged carrying case.

FEATURES

- High stability . . . within ±3 ppm during first year
- Low temperature coefficient, low power coefficient, low time constant
- Hermetically sealed construction
- Electrostatic shielding . . . thermally lagged case . . . equal accuracy in an air environment or an oil bath
- L&N Report of Calibration and temperature coefficient data are included

SPECIFICATIONS

Nominal Value 10,000 ohms

Accuracy ±3 ppm of nominal at 25° C

L&N Report of Calibration The resistance value is stated to 0.1 ppm with a calibration uncertainty of ±1 ppm at 25° C. Temperature coefficient data (*a* and *B* values) is also listed.

Stability Stable within ±2 ppm during first year, ±1 ppm in second year

Temperature Coefficient The Temperature coefficient is accurately expressed from 20 to 30° C by the equation
$R_t = R25\ [1+a(t-25)] + B\ (t-25)^2$
where the *a* value (temperature coefficient at 25° C) is less than ±0.2 ppm/° C and the *B* value (rate of change of temp coefficient) is less than ±0.05 ppm/° C^2. In addition to the *a* and *B* values listed in the Report of Calibration, a computer-calculated table is supplied listing corrections from 18 to 30° C in 0.1° C increments. The corrections are given to the nearest 0.01 ppm.

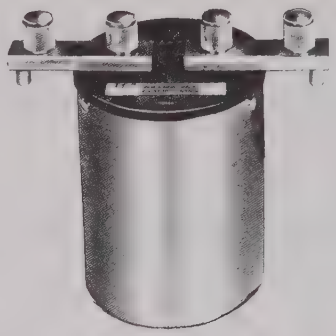
Power Coefficient 1 ppm/watt (in air); 0.3 ppm/watt (in stirred oil)

Power Rating 0.1 watt

Insulation Resistance Greater than 10^{11} ohms, resistance element to housing, at less than 70% RH

Voltage Breakdown 500 V peak between resistance element and housing

Dielectric Soakage Effect Resistance is stabilized to within ±0.1 ppm of final value within 10 seconds with 10 V applied to resistance standard.



Thermal EMF Under normal test conditions, a thermal EMF at the terminals does not exceed 0.1 uV

Phase Angle The phase angle is such that up to 1592 Hz the equivalent resistance does not deviate from the dc value by more than 5 ppm.

Current Reversal Resistance value changes less than ±0.1 ppm with reversal of current through resistance standard

Construction The woven, Evanohm resistance elements are mounted in a brass container and hermetically sealed to eliminate the effects of humidity. A copper terminal design is provided to accommodate either two or four extension leadwire (AWG 13 to 22) and/or mercury cups. A thermometer well is located in the center of the standard to allow insertion of a thermometer. This can be accomplished while the standard is mounted in the thermally lagged carrying case.

Thermally Lagged Case The carrying case for the standard is thermally lagged to allow use of the standard in an air environment. The metal shell of the case provides full electrostatic shielding on all sides. An opening is provided in the side of the case for the insertion of extension leadwires to the standard. The shield for extension wires may be connected to the case ground post located next to the opening. The hole at the top of the case permits temperature measurement without opening the case.

Temperature Sensor A calibrated mercury-in-glass thermometer is supplied with a range of 15 to 30° C. A resolution of 0.1° C and an accuracy of ±0.1° C permits temperature coefficient corrections to the nearest 0.1 ppm. The thermometer can be used for monitoring the internal temperature of the standard during a continuous measurement.

Dims Standard Only: 6-5/8" H x 4" dia (168 x 102 mm). Terminal spacing, 6-1/4" (159 mm). Carrying Case: 8-1/4" W x 6-1/4" D x 7-1/8" H (210 x 159 x 181 mm).

Weight Standard Only: 5-1/2 lb (2.5 kg). Standard in Case: 12 lb (5.4 kg).

Data Sheet A5.1111 DS

D-C RESISTANCE STANDARDS

L&N Standards Lab is prepared to recalibrate *all* resistance standards

REICHSANSTALT TYPE STANDARDS, 422☐-B

For use in the accurate measurement of current with a potentiometer and as standard for comparison in low resistance measurements. Design based on resistors developed at the Reichsanstalt.

In the 4222 and 4223, a strip or sheet of manganin is supported between two terminal rods. Manganin elements are enameled after final adjustment. In the 4221, the manganin resistor is bifilar wound. To obtain the current carrying capacities listed, these resistors must be immersed in stirred oil baths and must be used only as four-terminal resistors.

NBS TYPE STANDARDS, 40☐☐-B

Designed for use as standards in industrial, research, and educational laboratories.
Lower-value resistors are made of selected manganin wire, wound bifilar on metal spools, stress-relieved and aged to assure stability. In the higher values, woven manganin elements are used (except 4050-B which is of selected Evanohm). The coil is immersed in moisture-free oil in a sealed metal container.

Construction permits immersion of whole unit in oil for better temperature equalization and higher current rating. All leads are sufficiently heavy to permit connecting units in series or parallel without departing from the computed value of the combination by more than the guaranteed limit of error.

4020 to 4050 N.B.S.: The head is of epoxy plastic, molded around the terminals and thermometer well to provide an excellent oil seal. Insulation resistance between either arm and case of better than 10^{14} ohms allows minimum shunting effect.

The brass spools on which resistors are mounted have essentially the same coefficient of thermal expansion as the manganin wire.

INTERMEDIATE VALUE STANDARDS, -X☐ See Table

To specify desired resistance, add the basic resistance *multiplier* in the blank following the letter "X".
Example: 4222-B-X5 identifies a 0.05-ohm standard (five times the basic resistance of 0.01 ohm) and similarly 4020-B-X5 a 5-ohm standard; 4030-B-X5 a 500-ohm standard; 4035-B-X7.5 a 7500-ohm standard, etc. For intermediate values of resistance that do not adhere to the above listings or increments, consult North Wales (EIC).

GENERAL SPECIFICATIONS, D-C RESISTANCE STANDARDS. Complete per Table on next page.

Resistance ______ absolute ohm (s); based on standards maintained by L&N and certified at regular intervals by the NBS
Current Rating ______ amp (s) (if listed)
Wattage Rating ______ watt (s)
Adjusted to ______ % of nom. value

4221, -22

Calibration Report Supplied with L&N Report of Calibration which gives:
(a) Temperature coefficient data▲. For NBS Type standards, data is in a computer calculated table giving the resistance to the nearest 0.1 ppm for every 0.1 C from 18 to 30 C. For other standards, alpha and beta values for the R_t equation are given.
(b) Measured value at 25 C with accuracy indicated.

For 4015-B, both 2-terminal and 4-terminal values.

Measured Value Stated to_______(percent)

Limit of Error _________% of measured value at time of calibration. Stability of measured value for a period of one year . . . 4020-B, 4025-B, 4030-B, 4035-B, 4040-B, 4221-B and 4222-B within ±0.001%; other standards (except 4015-B) within ±0.002%. To obtain highest degree of accuracy, standard should be immersed in stirred oil bath.

Dims _______
Weight _______lb(s)

4020 Series

▲ *T.C. data not supplied for Cat. 4015.*

Standards
RESISTANCE STANDARDS

LIST NUMBER	RESISTANCE (OHMS)	CURRENT RATING AMPERES	WATTAGE RATING	ADJ. TO NOM. VALUE	MEAS. VALUE▲ STATED TO:	ACCURACY OF MEAS. VALUE	DIMENSIONS & WEIGHT
REICHSANSTALT TYPE D-C RESISTANCE STANDARDS, INTEGRAL AND INTERMEDIATE (-X☐)							
4223-B★	0.001	30, 100,	1 Watt, 10 Watts	±0.005%	±0.0001%	±0.002% (30) ±0.05% (100)	7" x 7-1/2" x 3-1/2" Weight...3 lb.
4222-B	0.01	10, 30		±0.003%	±0.0001%	±0.001% (for smaller current) ±0.05% (for larger current)	7" x 6" x 3-5/8" Weight...2 lb.
4221-B	0.1	3, 10					
4222-B-X☐	0.002, 0.005 0.02 or 0.05	- -		±0.005%	±0.0001%	±0.002% (for smaller wattage) ±0.05% (for larger wattage)	
4221-B-X☐	0.2, 0.5, 2.0, 5.0 or 10	- -					
NBS TYPE D-C RESISTANCE STANDARDS, INTEGRAL AND INTERMEDIATE, (-X☐)							
4015-B	0.1	3	0.1 Watt, 1 Watt	±0.05%	±0.01%	±0.05%	4" x 7" x 1-7/8"
4020-B	1	0.3, 1.0		±0.003%	±0.0001%	±0.001% (for smaller current) ±0.02% (for larger current)	
4025-B	10	0.1, 0.3					
4030-B	100	0.03, 0.1					
4035-B	1000	0.01, 0.03					
4040-B	10,000	0.003, 0.01					
4045-B	100,000	0.001, 0.003		±0.005%			
	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	
4020-B-X☐	2 to 9 ohms in increments of 1 ohm	- -		±0.005%	±0.0001%	±0.002% (for smaller wattage) ±0.02% (for larger wattage)	
4025-B-X☐	15 to 95 ohms in increments of 5 ohms	- -					
4030-B-X☐	110 to 990 ohms in increments of 10 ohms	- -					
4035-B-X☐	1100 to 9900 ohms in increments of 100 ohms	- -					
4040-B-X☐	11,000 to 99,000 ohms in increments of 1000 ohms	- -					

▲*TEMPERATURE COEFFICIENTS - For most standard resistors, the resistance at any temperature in the interval 20 to 30 C does not differ from the resistance at 25 C by more than 50 parts per million. Within the interval 15 to 35 C, the change of resistance with temperature for a manganin resistor is accurately expressed by the equation:*

$$R_t = R25 \left[1 + \alpha (t-25) + \beta (t-25)^2 \right]$$

Where Rt is the resistance at t C, R25 is the resistance at 25 C and α *and* β *are constants included in the report data. Experience shows that the coefficients* α *and* β *do not change appreciably with time and hence need to be determined only once.*

★*Similar to 4210 Thomas Type having both mercury-contacts and screw terminals for current connections.*

4333 SECONDARY STANDARD RESISTOR, 0.001 OHM 4 TERMINAL

APPLICATION Designed for use as a working standard resistor for general laboratory application and as a range extending external standard for 4287 Kelvin Bridge. Can be used in either of three connection arrangements:

1. Using internal power supply and internal switching.
2. Using external power supply and internal switching.
3. Using external power supply and external yoke.

SPECIFICATIONS *(Physically similar to the 4631 Resistors, A-C)*

Resistance 0.001 ohm.

Limit of Error ±0.02% from 0 to 30 amperes.

Current Rating 30 amperes maximum.

Connections Four acrylonitrile — styrene binding posts.

Element Resistance element consists of a strip of manganin supported between the terminals.

Case Metal case and top plate.

Dimensions 3-3/4" W x 5-1/2" L x 3-3/4" D (95 x 140 x 95 mm).

Weight Net, about 1 lb, 4 oz (0.56 kg); shipping about 2.5 (1.1 kg).

SHUNT BOXES FOR USE WITH POTENTIOMETERS, CURRENT MEASUREMENTS, See 10.5-7-2.

4361 RESISTOR (SHUNT) FOR LARGE CURRENTS

APPLICATION Primarily for use in accurate measurements of large currents by the potentiometric method. May be used as comparison standards for measuring resistance by either the potentiometric or the adjustable ratio Kelvin bridge method. May be used in place of the Reichsanstalt type if a ±0.04% limit of error is satisfactory.

FEATURES Provides ample contact with bus bars or corresponding parts of current circuits. Ample radiation surface for operation in air at ordinary room temperatures.

SPECIFICATIONS Complete specs per table.

Resistance 0.01 ohm. Adjusted to rated resistance between the potential contacts.

Limit of Error ±0.04 percent, with air cooling at ordinary room temperature for any current up to its full rating.

Connections Four terminal current/potential type.

Current Rating (Amperes) 100

Potential Drop, In Volts, With Maximum Current 1.0

Size 20 x 8 x 7-1/2

Weight 15 lb

Shipping Wt. 25 lb

Back is intentionally blank

SHIELDED DC RESISTANCE BOXES

ADVANTAGES

Totally enclosed construction . . . keeps out dust, reduces maintenance
Switches provide low, stable contact resistance
Terminals with high insulation resistance

FEATURES

Silver switch contacts
Gold-plated terminals mounted on polystyrene bases
Metal case and top-plate . . . electrostatic shielding

4754 SHIELDED DC RESISTANCE BOXES

A resistance box which provides standards of dc resistance in research and production testing.

Range ....1 to 11,110 ohms
Resistors ....Six per decade (two single-value, four double-value). Lower decades (to 1-ohm) are strip resistance material in insulated multibifilar folds; for higher decades, resistors are of parallel-opposed wound or woven types to provide optimum a-c characteristics.
Zero Resistance.....Does not exceed 0.003 ohm per decade.
Resistance Change...D-C change from zero setting, measured across binding posts, equals dial settings ± (0.05 percent +0.005 ohm)
Contact Stability...Under normal conditions of usage: ±0.0005 ohm per decade.
Current Rating......

Highest Decade In Use	Rating (Amperes)
1	0.5
10	0.11
100	0.035
1000	0.011

Case................Aluminum alloy, gray finish
Dimensions..........15-7/8" x 4-1/2" x 6" high (503 x 114 x 152 mm)
Weight..............Net, about 8 lb (3.6 kg); shipping, about 14 lb (6.4 kg)

BINDING POSTS: In precision alternating current measurements the "low" binding post should be connected to the terminal of the circuit which is nearest ground potential, the "high" binding post to the terminal of the circuit which has the higher potential above ground. The "ground" binding post is connected to the metal case of the decade resistance box which serves as a shield. Depending upon application, there are four combinations in which the "low" and "ground" binding posts are used:

(1) Connected by jumper and "ground" post grounded
(2) Connected by jumper and "ground" post not grounded
(3) Not connected and "ground" post grounded
(4) Not connected and "ground" post not grounded

4755 SHIELDED DC RESISTANCE BOXES

Same as 4754 except:

Range...............0.1 to 11,111 ohms
Current Rating......

Highest Decade In Use	Rating (Amperes)
0.1	1.6
1	0.5
10	0.11
100	0.035
1000	0.011

Dimensions..........19-1/4" x 4-1/2" x 6" high (489 x 114 x 152 mm)
Weight..............Net, about 9 lb (4 kg); shipping, about 17 lb (7.7 kg)

4756 SHIELDED DC RESISTANCE BOXES

Same as 4754 except:

Range...............1 to 111,110-ohms
Current Rating......

Highest Decade In Use	Rating (Amperes)
1	0.5
10	0.11
100	0.035
1000	0.011
10,000	0.003

Dimensions..........19-1/4" x 4-1/2" x 6" high (489 x 114 x 152 mm)
Weight..............Net, about 9 lb (4 kg); shipping, about 17 lb (7.7 kg)

4757 SHIELDED DC RESISTANCE BOXES

Similar in appearance to 4754, 4755 and 4756 Resistance Boxes, except having two rows of three (3) dials.

Total Resistance:	11,111.10 ohms
Decade Steps:	10(0.01 + 0.1 + 1 + 10 + 100 + 1000)
Limit of Error:	In resistance change from zero setting dial settings ± (0.05% + 0.005 ohm)
Contact Stability:	±0.0005 ohm per decade
Dimensions:	12-9/32" x 7-17/32" x 5" (312 x 191 x 127 mm)

4775 AND 4776 ENCLOSED-SWITCH RESISTANCE BOXES

An adjustable resistance box designed for general use in d-c circuits

APPLICATION: Suitable for commercial power frequency a-c as well as d-c.

SPECIFICATIONS

[1]Limit of Error....	D-C resistance change from zero setting, measured across binding posts, equals dial settings ±(0.1% + 0.01 ohm)
Rating...........	When highest decade in use is 0.1, 1.0, 10.0, 100.0 and 1000.0, current rating is 1.6, 0.5, 0.16, 0.05 and 0.016 amperes respectively.
Dials............	Four. Five resistors in each, connected to provide a zero position and nine equal steps of resistance change for each 180 degrees of rotation of the switch.
Case..............	Molded bakelite case, 5-7/8" x 6-1/8" x 4-3/8" (149 x 156 x 111 mm)
Weight............	Net, about 4 lb (1.8 kg); shipping, about 6 lb (2.7 kg)

LIST NO.	RESISTANCE (OHMS)	DECADE STEPS
4775	9999.0	9(1 + 10 + 100 + 1000)
4776	999.9	9(0.1 + 1 + 10 + 100)

SPECIFICATIONS

Total Resistance...	0.0101 ohm
Adjustable Std.....	0.0011 ohm. Continuously adjustable
Fixed Standard.....	9 x 0.001 ohm. Plug and block controlled, in series with bar. Arrangement is equivalent to having a graduated bar ten times as long as the one used; also provides a precision of setting correspondingly greater than if the bar alone provided the total resistance of the standard.
Limits of Error....	Of fixed standard: up to 0.005 ohm, ±2 microhms; above 0.005 ohm, ±0.04 percent. Of adjustable standard: ±2 microhms
Adj. Standard Scale..............	110 divisions, with vernier providing 1 microhm readability
Current Rating.....	For 10-minute period: 50 amperes in entire standard, 150 amperes in bar alone. For continuous duty: 30 amperes in entire standard, 90 amperes in bar alone.
Base...............	Polished mahogany, 3-7/8" x 8-7/8" x 6-7/8" (784 x 225 x 175 mm)
Weight.............	Net, about 18 lb (8 kg); shipping, about 28 lb (12.7 kg)

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1. Statement assumes that box has been in regular use, or that dials will be rotated before box is put in use after period of idleness. DC resistance, with all dials at zero, does not exceed 0.03 *ohm.*

FIELD NOTE: The resistance momentarily becomes zero during switching between positions 1 and 2, requiring due precaution when used as a current-regulating rheostat.

DC RESISTORS, WIRE WOUND, COMPACT SEALED OR PROTECTED, TYPES SR AND PR

ADVANTAGES

Values from 0.5 ohm to 500,000 ohms. Both types available with either Manganin or Evanohm® resistance wire.

High stability

Widely used in L&N precision instruments.

BUILT-UP CATALOG NUMBER

1 2 3 4 5 6
□□ — □□□ — □ — □.□□ — □ — □.□

Example: **SR — 100 — M — 0.01 — A — 0.5**

Identifies a fully-sealed resistor, 100-ohms, manganin wire, ±0.01% accuracy, axial-center leads, with resistance adjusted for terminal connections one-half inch from the body of the resistor.

IDENTIFICATION OF BUILT-UP CATALOG ELEMENTS: See specs for limitations

1. Type: SR or PR
2. Value in Ohms: As specified
3. Resistance Wire: M for manganin or Evanohm
4. Accuracy: As specified
5. Lead Arrangement: A or B: C: D as specified
6. Inches: As specified to point of adjustment.

SPECIFICATIONS

Resistance Wire

MANGANIN:

Value of Resistor: Specify for resistors having values from 0.5 ohm to 50,000 ohms.

Temperature Coefficient: 10 ppm/°C max. over range 20 to 35 C.

EVANOHM:

†Value of Resistor: Specify for resistors having values from 50,000 to 500,000 ohms.

Temperature Coefficient: 10 ppm/°C max. over range -10 to +60 C.

Winding Bifilar for resistors up to 350 ohms, reverse pi for resistors of greater value.

Wattage Rating 0.1 W for 15 C rise.

Type	SR Wound on ceramic spool and fully sealed in epoxy shell	PR Wound on ceramic spool and mechanically protected with polyethylene cover
Standard Accuracy	Specify: ±0.01%△, ±0.02%△, ± 0.05% or ±0.1% at 25 C	Specify: ±0.05%, ±0.1% or ±0.5% at 25 C
Stability	30 ppm/yr	50 ppm/yr
Dimensions	0.750" x 0.437" OD	0.500" x 0.425" OD
▲Leads	#20 copper wire, approx. 2-1/2" per lead A: Axial center, two terminal or C: One-sided, two terminal or D: Four-terminal	#20 copper wire, approx. 2-1/2" per lead B: Axial off-center, two terminal or C: One-sided, two terminal or D: Four-terminal
Point of Adjustment	For two terminal resistors only, specify: _______ inches along leadwire from case to points where connections will be made.	

PRICES See Section 1.1-2-1

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† Evanohm may also be specified for resistors of lower value.

▲ A four-terminal lead arrangement (D) is recommended for low-value, high-accuracy resistors (one inch of #20 copper wire equals approximately 0.001 ohm).

△ For four-terminal and resistors 100 ohms and higher.

DC RESISTORS, WIRE WOUND, UNSEALED CERESIN-COATED

Wire wound resistors which find wide application in dc instrumentation where high accuracy under normal ambient temperature conditions (about 20 to 35 C) is required. Comprising L&N manganin wire wound on an enameled brass spool and coated with ceresin (wax), the resistors are available in the three sizes and the variety of standard resistance values shown below.

10-5-13-□ SERIES RESISTORS

Standard Accuracy ±(0.05% + 0.003 ohm) at 25 C.

(Resistors with a value of 50 ohms or higher can also be supplied, on special order, with an accuracy of ±0.02% at 25 C.)

Wattage Rating 0.1 W

Dimensions 1-1/8" x 1/2" OD

Resistance, Ohms	Part Number	Resistance, Ohms	Part Number
0.1	10-5-13-1	20	10-5-13-6
0.2	10-5-13-2	100	10-5-13-7
1	10-5-13-3	200	10-5-13-8
2	10-5-13-4	1000	10-5-13-9
10	10-5-13-5	2000	10-5-13-10

10-1-13-□ SERIES RESISTORS

Standard Accuracy ±(0.05% + 0.003 ohm) at 25 C.

(Resistors with a value of 50 ohms or higher can also be supplied, on special order, with an accuracy of ±0.02% at 25 C.)

Wattage Rating 0.2 W

Dimensions 2-3/16" x 1/2" OD

Resistance, Ohms	Part Number	Resistance, Ohms	Part Number
1	10-1-13-1	300	10-1-13-13
2	10-1-13-2	400	10-1-13-14
3	10-1-13-3	500	10-1-13-15
4	10-1-13-4	1000	10-1-13-16
5	10-1-13-5	2000	10-1-13-17
10	10-1-13-6	3000	10-1-13-18
20	10-1-13-7	4000	10-1-13-19
30	10-1-13-8	5000	10-1-13-20
40	10-1-13-9	10000	10-1-13-21
50	10-1-13-10	20000	10-1-13-22
100	10-1-13-11	30000	10-1-13-23
200	10-1-13-12		

10-0-13-□ SERIES RESISTORS

Standard Accuracy ±(0.01% + 0.003 ohm) at 25 C.

Wattage Rating 0.5 W

Dimensions 3-1/32" x 5/8" OD

Resistance, Ohms	Part Number	Resistance, Ohms	Part Number
1	10-0-13-1	1000	10-0-13-4
10	10-0-13-2	10000	10-0-13-5
100	10-0-13-3		

AVAILABLE ON SPECIAL ORDER (1) Resistors of other than the standard values listed to a maximum of 30,000 ohms; (2) matched sets of resistors; (3) resistors adjusted on the low side of a specific resistance value, for adjustment or padding after the resistor has been wired into the circuit.

THERMOCOUPLE CALIBRATING EQUIPMENT

Designed specifically for thermocouple checking in which production thermocouples can be compared accurately and reliably against a reference standard thermocouple.

A complete checking facility consists of three items which are ordered separately.

1. A Potentiometer Measuring Facility
2. A Checking Furnace (with Controls)
3. An Equalizing Block for use in the Furnace

1. POTENTIOMETER MEASURING FACILITY

The potentiometer measuring facility is used to make precise comparisons of thermocouples to a reference thermocouple when they are inserted into the equalizing block within a checking furnace. The recommended facility includes a K-5 Potentiometer as follows:

7555-A31-C1 Type K-5 Potentiometer Facility

Field Note: For additional potentiometer specs, see Sect. 10.5-1-3.

SPECIFICATIONS

Consists of a cabinet-mounted assembly of a 7555 Type K-5 Potentiometer, 9828-1 Guarded DC Null Detector, 7308 Unsaturated Standard Cell and 9879 Guarded DC Constant Voltage Supply. Also includes 15-point panel-mounted switch for selecting thermocouple inputs (suffix -C1). Thermocouple calibration requires the use of an ice point reference. This can be accomplished with a thermos jar filled with ice made from distilled water. Some users may prefer to use an electrically operated ice point reference such as Kaye Instruments Model K140-4.

Contact Kaye Instruments Inc.
15 De Angelo Drive
Bedford, MA 01730

Ranges

High (1.6):	-500 μV to +1.61050	volts
Med (0.16):	-50 μV to +0.161050	volt
Low (0.016):	-5 μV to +0.0161050	volt

Limits of Error

High Range	(1.6):	±(0.005% of reading +20 μV)
Med Range	(0.16):	±(0.007% of reading +2.0 μV)
Low Range	(0.016):	±(0.007% of reading +0.5 μV)

Power Requirements 120 V, 50/60 Hz (23 watts)

The K-5 Facility has sufficient resolution to provide an accuracy of comparison that is usually better than 0.2 F —0.3 F, depending on type of couple being checked.

2. THERMOCOUPLE CHECKING FURNACE

The thermocouple checking furnace is used to provide a work area with uniform temperature in which thermocouples can be compared to a reference thermocouple. Different types of controls are made available which allow the user to set the work area temperature to some nominal value up to a maximum of 2000 F. The precise measurement of the work area is measured with the reference thermocouple used in the checking procedure. The uniformity in the work area is about ±3 F and can be improved to about ±1 F by using an equalizing block (see specifications).

09009-☐ THERMOCOUPLE CALIBRATING FURNACE (FACTORY ASSEMBLED)

Equalizing Block

09009 Calibrating Furnace

Work Space 4" dia x 30"D (10.2 x 77 cm).

Heater 3.6 KW

Operating Temperature 300 to 2000 F.

Checks Can be made with a least uncertainty of about ±3 F over the range of 300 to 1850 F.

This can be improved with use of equalizing block to approx. ±1 F from 300 to 1000 F; approx. ±2 F up to 2000 F.

Overheat Protection Gold fuse and contactor.

Power Supply Required Operates on 115 or 230 V, 60 or 50 Hz, single phase, as specified by catalog number final numerical group.

Outside Dimensions 18-1/4" square base x 16-1/4" square jacket x 42"H (46 x 41 x 107 cm).

Specify One of The Following

CAT. NO.	TYPE OF CONTROL
(742267) 09009-A13 (115 V) or (742268) 09009-A12 (230 V)	**Manual Control ... Mounted By User** Powerstat and conductor are supplied separately and must be mounted by user
(742269) 09009-A23 (115 V) or (742270) 09009-A22 (230 V)	**Manual Control ... Factory Mounted and Wired** Steel panel enclosure (18-1/4" sq. base x 16-1/4" sq. body x 42"H) (46.4 x 41.2 x 107 cm) with the following mounted and wired: operating switch; Powerstat, contactor and terminal board.
(745822) 09009-C33; 115 volts (745823) 09009-C32; 230 volts	**Electromax Control ... Factory Mounted and Wired** Steel panel enclosure (18-1/4" sq. base x 16-1/4" sq. body x 56"H) (46.4 x 41.2 x 142 cm) with the following mounted and wired: operating switch; Powerstat, contactor, relay, transformer, fuse block, terminal board, Ni-Cr vs Ni-Al control thermocouple (in 09009) and 6012-3-04-1-0-00-00-103 Electromax V Plus Controller having the following specifications. **Range** 0 to 2500 F - Type K **Control Element** Two-Position **Control Point Setter** On front of case **Ref. Jct. Compensator** Automatic **Safety Features** Upscale or downscale thermocouple failsafe is selected by using Jumper W1 on the analog board. See Fig. 5-2 of 277650 Directions. **Power Supply** Operates 120 V, 60 or 50 Hz

CAT. NO. **TYPE OF CONTROL**

HIGH LEVEL OUTPUTS (SUFFIX H103)

This option will produce a current output proportional to the set point, deviation, process variable or percent of any proportioning controller output. A second C.A.T. output printed circuit card is required. Current output may be 4 to 20, 0 to 20, 1 to 5 or 0 to 5 mA as selected by configuration code and jumper on the output card. Refer to 11-1.3 of 277650 Direction Book.

The steel panel enclosure supplied with the C32 and C33 options will include a circuit for a Speedomax 100 recorder. If a recorder is required, list catalog 121-304-00-C0069-6-FO, range 0 to 2500 Deg F linear (controller output is linearized). As a separate item on the order, the recorder will be mounted and wired by the customer. Refer to Direction Book 177326. For customer connections. For complete specifications on:
 Recorder, see section 6.2-5-1
 Controller, see section 8.1-1-1.

Cat. 09009 Directions 177326
Electromax V Plus Operator's Manual 277650
Speedomax 100 Series Recorder Operator's Manual 277182

3. EQUALIZING BLOCKS

When comparisons are made in an 09009 Furnace *without* an equalizing block, the measuring junctions of the thermocouples to be checked may be bound to the Laboratory Standard thermocouple with all measuring junctions in intimate contact. When immersed, any space around the couples at the entry hole must be closed with suitable insulation to prevent circulation of air into the heating chamber. Another acceptable method is to insert the bound thermocouples into a closed-end ceramic tube to aid in positioning and improve temperature uniformity.

Optimum thermal uniformity and stability are obtained by mounting an equalizing block in the furnace; see "Checks" in Specs below.

SPECIFICATIONS

Application For temperatures ______________

Material ______________ Block with pedestal and ceramic centering spacers

Checks Can be made with a least uncertainty of about ______________

See Table below

Accommodation Seven immersion holes, one at center for insertion of laboratory standard, six 9/16" dia. holes on 1" radius for insertion of couples to be compared.

Dimensions 3" dia. x 14"L (76 x 356 mm)

Weight Approx. 30 lb

PART NO.	MATERIAL	APPLICATION	CHECKS
127379	Copper	up – 800 F	±1 F 300 – 800 F
127383	Aluminum-Bronze Alloy	up – 1850 F	±1 F 300 – 1000 F ±2 F – 1850 F
127382	Inconel	1850 F – 2000 F only	±2 F

ACCESSORIES

18710-B-K2025-24-☐ Platinum, 10% Rhodium-Platinum Primary Standard Thermocouple. For specs, see Sect. 5.1-1-1.

103007 Mercury, 8 oz. For use in amalgamating thermocouple wire to copper wire in Ref. Junction Ice Bath. ★

CONVERSION OF 09009 to 8411-☐ FIXED TEMPERATURE STANDARD

124747 Kit of Parts Converts an 09009 Thermocouple Checking Furnace to an 8411 Fixed Temperature Standard. Consists of:

Part No.	Quantity	Quantity
402146	Lid Brick	4
402430	Lid Brick	2
061655	Stud	1
267074	Housing	1
190033	Freeze Rod	1
034693	Centering Insulator	1
004088	Screw	1
004111	Shoulder Screw	1
004721	3/8 #10–32 RHI, Cad. Pl.	2
001365	#10 K.L.L.W.	2
177441	Directions for Cat. 8411	1
Dwg J-2406-20		1

8411-☐-C Charged Cell

127☐☐☐ Equalizing Block required for 8411.

REPLACEMENT PARTS FOR 09009

426098	Contactor (for 115 V operation)
411004	Control TC Element
035128	Top Brick
036020	Furnace Relay
014082	Gold Temp-Limit Fuse Element
116108	Heater Unit (for 230 V operation)
116110	Heater Unit (for 115 V operation)
019185	Step-Down Trans (for 230 V operation)
019302	Variable Trans (for 115 V operation)
019303	Variable Trans (for 230 V operation)
032336	On-Off Switch
402143	Bottom Brick (for A12, A13, A22, A23 Suffixes)
402145	Lid Brick (seven hole)
402173	Lid Brick (single hole)
402428	Bottom Brick (for B32, B33, B42, B43 Suffixes)
426063	Contactor (for 230 V operation)

★ Ice Point Reference: Thermocouple calibration requires the use of an ice point reference. This can be accomplished with a Thermos jar filled with ice made from distilled water. Some customers may prefer to use an electrically operated ice point reference such as Kaye Instruments Model K140-4. Customers should contact Kaye Instruments Inc., 15 De Angelo Drive, Bedford, MA 01730.

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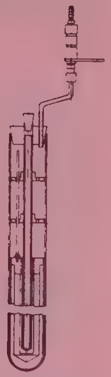
8411-□ FIXED TEMPERATURE STANDARDS

8411 Fixed Temperature Furnace



74□□□□
Freezing Point Cell

FEATURES

- Interchangeable cells and equalizing blocks . . . a single furnace can serve any of the fixed temperature standard cells
- Immersion depth of 18" provides maximum support for thermometer, reduces heat loss
- Temperature plateaus are of long duration
- Simple control system

ADVANTAGES

Eliminates frequent test comparisons against certified thermometers (stability of metal freezing points).

DESCRIPTION

An equipment designed to provide a precise calibration point for temperature sensors such as platinum resistance thermometers and thermocouples, utilizes the characteristic constant temperature plateau at the liquid-solid transition of high purity metals.

In operation, sufficient power is applied to the heater to raise the temperature of the metal above its melting point. The heater power is then reduced to a predetermined level. Because of the purity of the metal, it supercools. A stainless steel rod at room temperature is temporarily inserted in the sensor well. This results in the growth of a mantle of solid metal on the graphite protecting tube. Once the plateau is obtained, it can be held for an extended period.

The zinc point (L&N 742879) has been recommended as a replacement for the sulphur point on the International Practical Temperature Scale.* The zinc point is more reproducible than the sulphur point and the value which is assigned to it has been so chosen that its use leads to the same values of temperature on the scale as does the use of the sulphur point.

SPECIFICATIONS

COMPOSITION Each 8411 Fixed Temperature Standard consists of an electric furnace; a freezing point cell containing high-purity metal, a temperature equalizing block, and a freeze rod; and an autotransformer and contactor for controlling the furnace temperature.

The eight types of available fixed temperature standards and their corresponding catalog numbers are listed in Table 1. This table also lists data pertinent to the entire standard and to its components.

USEFUL FREEZE TIME

Normally between one to six hours, depends on the calibration requirement, furnace power adjustment, and number of temperature sensors calibrated. Stability is typically ±0.0005 C or better during the freeze plateau. Repeatability approximately ±0.002 C.

ELECTRIC FURNACE

Power Requirement 120 V, 50/60 Hz, 31.3 A, Single Phase or 240 V, 50/60 Hz, 15.7 A, Single Phase.
Max. Operating Temperature 1093 C.
Overheat Protection Gold Thermal Fuse.
Dimensions *Jacket:* 16-1/4" (0.413 m) square with a base 18-1/4" (0.464 m) square. *Overall H* 42" (1.067 m). *Cavity* 4" (0.102 m) in dia. by 30" (0.762 m) D.

FREEZING POINT CELL (See inset)

Metal See Table 1.
Transition Temperature See Table 1.
Uncertainty See Table 1.
Crucible Graphite crucible containing the metal has been purified after machining and has been selected for low ash content.
Cell Enclosure See Table 1.
Dimensions Overall 51 millimeters in diameter by 46 centimeters long.
Sensor Well 7.5 millimeters in diameter by 42.5 centimeters long.
Immersion Depth About 38 centimeters of the sensor well is in the furnace cavity and more than 18 centimeters is below the top surface of the metal charge.

EQUALIZING BLOCK

See Table 1.

8411-□ ORDERING INSTRUCTIONS

A complete Fixed Temperature Standard is made up of 3 items which are ordered separately:

1. 745773 or 745774 Furnace
2. 74□□□□ Freeze Point Cell
3. An Equalizing Block

Furnace

745773 (8411-10) .... Price: **$10,300.00**
Electric Furnace for 120 V 50/60 Hz operation. Includes separate Powerstat and contactor for installation by customer. Accepts any listed equalizing block and cell.

745774 (8411-11) .... Price:**$11,000.00**
Same as 745773 except for 240 V 50/60 Hz Single Phase operation.

Equalizing Block

127543 Copper
Use with In, Sn, Cd, Pb or Zn Cell

127604 Aluminum Bronze
Use with Sb or Al Cell

327554 Inconel
Use with Cu Cell

For Prices see Section 1.1-2-2

ACCESSORIES REQUIRED Regulated supply of inert gas such as argon or nitrogen. Used to purge cell while in operation to prevent contamination of the metal.

ACCESSORIES RECOMMENDED Cat. 8079 Type ER Thermometer Bridge.

REPLACEMENT PARTS 8411-□-C Charged Cell. *See table.* Temperature Equalizing Blocks. *See table.*

NOTE: TO CONVERT FROM LOW TO HIGH TEMPERATURE STANDARD: Order (2) 402430 Lid Bricks in addition to Charged Cell and Equalizing Block. Note that for low temperatures (Pyrex cell enclosure), standard is originally supplied with (4) 402146 Lid Bricks; for high temperatures (Vycor or quartz enclosure), standard is originally supplied with (2) 402146 and (2) 402430 Lid Bricks.

CONVERSION OF 09009-□ TC CHECKING FURNACE TO 8411 FIXED TEMPERATURE STANDARD
124747 Kit. See 10.3-3-2 Page 1-C.

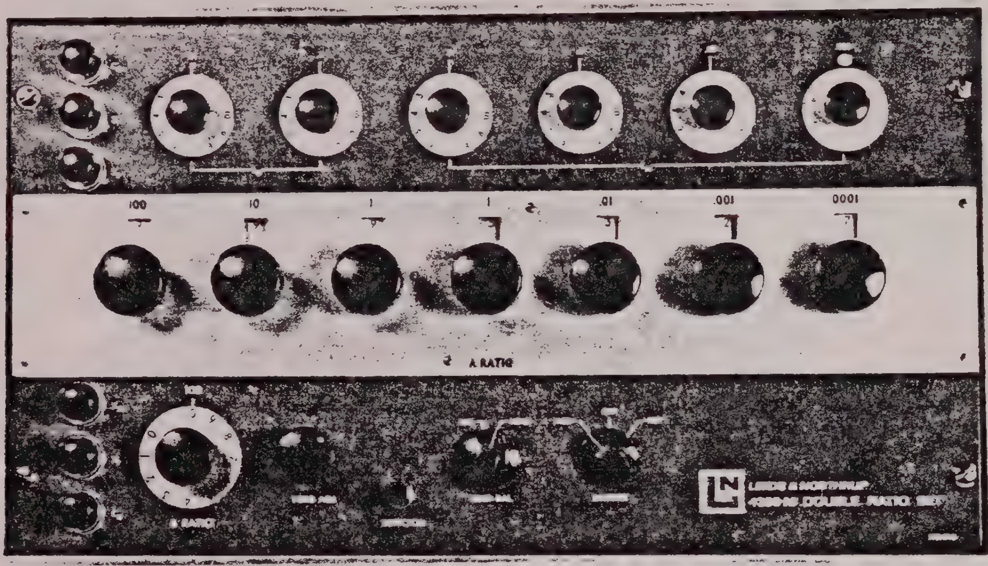
CONVERSION OF 8411 TO 09009 TC CHECKING FURNACE 127□□□ Equalizing Block. See 10.3-3-2, Page 1-C. Accessories for 09009 Furnace; 402173 Lid Brick, Single Hole, or 402145 Lid Brick, Seven Hole.

TABLE 1 FREEZE POINT CELL (Cat. 8411-□□-C Order by 6-digit number, see page 1-A photo)

Metal	Freeze Point Cell Part No.	Price	Transition Temperature IPTS-68 *	Uncertainty †	Cell Enclosure	Temperature Equalizing Block
Indium (In)	742875	**$ 11,490.00**	156.634° C	0.015° C	Outer container and sensor well made of Pyrex	Copper Part 127543
Tin (Sn)	742876	**5,200.00**	231.9681° C	0.015° C		
Cadmium (Cd)	742877	**5,200.00**	321.108° C	0.03° C		
Lead (Pb)	742878	**5,900.00**	327.502° C	0.03° C		
Zinc (Zn)	742879	**5,000.00**	419.58° C	0.03° C		
Antimony (Sb)	742880	**5,350.00**	630.74° C	0.1° C	Outer container and sensor well made of Vycor	Aluminum Bronze Part 127604
Aluminum (Al)	742881	**5,350.00**	660.37° C	0.1° C		
Copper (Cu)	744597	**5,350.00**	1084.5° C	0.2° C	Outer container and sensor well made of Quartz	Inconel Part 327554

* *International Practical Temperature Scale—1968.*

† *Uncertainty with respect to assigned values for IPTS-68.*



L&N Photo No. 45751-3

4398-M SEVEN-DIAL DOUBLE RATIO SET

ADVANTAGES

- Multi-functional...basic functions are:
  - Double Ratio Set for two- or four-terminal measurements
  - Direct Reading Ratio Set for resistance comparisons up to 1-megohm
  - Precise two-terminal Resistance Box, range 100 to 2111.1110-ohms in steps of 0.0001
- Continuously adjustable ratios from 100:1111.1110 to 1111.1110:100
- Basic ratios can be calibrated to 1-ppm
- Accurate measurements: 0.2 ppm limit of error as a Double Ratio Set or Direct Reading Ratio Set using direct substitution
- Engineered for convenience and speed of measurement
- Optional features...L&N Report of Calibration...Remote sequential readout

FEATURES

- In-line, covered dial readout of the "A" ratio arm...
  - Permits direct reading of ppm deviation* from the reference standard (eliminates necessity for algebraic additions of dial settings to "unity")
  - Provides instant recognition of plus vs minus deviations* (black or red complementary numbers respectively at each dial)
- Resolution: 0.1 ppm with "A" ratio set at nominal 1000-ohms
- Built-in lead compensation...resolution: 0.0002 ohm per scale division (0.2 ppm with 1000 ohms in main ratio)
- "Automatic" inclusion of reference standard's certified corrections...lead compensation dials in conjunction with "A" and "B" ratio arms permit "dialing-in" of correction factors in DRRS measurements
- LEAD BAL switch provides for shorting ratio arms in making lead balance
- Switch for reversing battery polarity, 20-A rating
- Critical resistors matched for temperature coefficient and treated for stability
- Waidner-Wolff shunt-type decades and paralleled contacts to minimize contact resistance variation
- Electrostatic shielding...metal case and top plate
- Functional design...Retractable legs for 30° or 50° inclination of top plate with horizontal... Rear deck terminals for seldom-changed connections

When used as a Direct Reading Ratio Set

SEVEN-DIAL DOUBLE RATIO SET

4398-M	FOR BENCH USE
4398-M-1	FOR 19" RELAY RACK MOUNTING
4398-M-A30	FACILITY, with 9828-1 Null Detector
4398-M-A31	FACILITY, with 9828-1 Null Detector and 9876-M-1 Power Supply

The 4398-M Seven-Dial Double ratio Set blends high precision and accuracy with convenient operating features to result in an instrument that excels in rapid and accurate measurements of medium and low resistances. (See photopage.)

SPECIFICATIONS, GENERAL

Ratio Selection..........	Provided by L&N Type 01 fully-enclosed rotary switches which have silver-silver alloy contacts. Contacts are paralleled where necessary to make negligible the effect of contact resistance
A-Ratio..................	Seven decades spanning 100 to 1111.1110-ohms in steps of 0.0001-ohm. All except the 100-ohm/step decade are Waidner-Wolff shunt-type to minimize the effects of contact resistance. The 100, 10, and 1-ohm/step decades utilize parallel contacts. Each of last six decades has two numbers associated with each dial position. These numbers, appearing in a rectangular window at each decade, provide direct reading, in ppm, of the deviation of the test resistor from its nominal value when the instrument is setup as a Direct Reading Ratio Set. The black numbers provide direct reading for a resistor having a value higher than nominal, and the red numbers are direct reading for a resistor lower than nominal
B-Ratio..................	One decade spanning 0 to 1000-ohms in steps of 100-ohms
Yoke Ratios..............	Electrically the same as the "A" and "B" battery ratios described above, and mechanically coupled to them to turn simultaneously to the same resistance setting
Resolution...............	When A-ratio is set at a nominal 1000-ohms, the resolution is 0.1-ppm
Lead Compensation........	LA is a four-dial adjustable resistance in series with the A-ratio arm (battery circuit) and has a range of 1 to 11.110-ohms. The lowest dial has 0.0002-ohm graduations and can be easily read to the nearest 0.0001-ohm. LB is a two-dial adjustable resistance in series with the B-ratio arm (battery circuit) and has a range of 0 to 11-ohms in steps of 0.1-ohm In addition to their normal function of compensating the measurement for the effect of unbalance in lead resistances, these dials can be used in conjunction with the A and B-ratio arms to permit "dialing-in" the certified correction of the external standard resistor used in D.R.R.S. measurements. Thus, the final reading is automatically corrected for the known deviation of the standard resistor from its nominal value. A single adjustment, YOKE ADJUST, is provided to compensate for the effect of unbalance in the leads connected to the yoke ratio arms. This uncalibrated 10-turn potentiometer is connected in the apex of the yoke ratio arms
Maximum Voltage..........	One-volt per 100-ohms in ratio arms. Maximum current when used as a resistance box is 10-mA
Ratio Resistors..........	All 100-ohm resistors are selected-peak Evanohm, and all other critical resistors are wound from L&N Grade A Manganin wire, matched for temperature coefficient and treated for stability
Battery Switch...........	Three-position rotary type reversing switch marked NORMAL, OFF, REVERSE. Rating is 20-amps maximum
Keys.....................	Low-thermal detector key can be locked down
Lead Balance Switch......	Two-position rotary type switch marked LEAD BALANCE and MEASURE
Terminals................	Gold-plated copper binding posts with acrylonitrile insulation. Six on front plate for connecting two four-terminal resistors. Seven on rear deck: two for bridge battery, two for detector, one for ground, and two for connections to the A and B-ratio arms for use as a precision resistance box
Resistance Box...........	Two rear-mounted terminals, RL and RH, permit use of the A and B-ratios as a two-terminal resistance box. Range is 100 to 2111.1110-ohms in steps of 0.0001-ohm

Limits of Error..........

Magnitude	Application
20-ppm	Double Ratio Set without corrections
10-ppm	Double Ratio Set with corrections
0.2-ppm	Double Ratio Set using direct substitution
0.2-ppm	Direct Reading Ratio Set using direct substitution
±0.003Ω for change from minimum setting	Two-terminal Resistance Box

ADDITIONAL SPECIFICATIONS REQUIRED BY LIST NUMBER

4398-M SEVEN-DIAL DOUBLE RATIO SET FOR BENCH USE

Case.....................	Aluminum top plate and case; provides electrostatic shielding. Case is provided with retractable legs permitting two position mounting. Normal position inclines top plate at an angle of 30 degrees with the horizontal. With legs extended the top plate is inclined at an angle of 50 degrees with the horizontal
Dimensions...............	19-1/4"W x 11"H x 9-1/2"D (489 x 279 x 241 mm) with legs retracted; 11-3/8"D (289 mm) with legs extended
Weight...................	Net, about 24 lb (11 kg); shipping about 28 lb (12 kg)

SEVEN-DIAL DOUBLE RATIO SET (Cont'd)

4398-M-1 SEVEN-DIAL DOUBLE RATIO SET FOR 19" RELAY RACK MOUNTING

Case................Aluminum top plate, sheet metal case; provides electrostatic shielding
Dimensions..........19" wide x 10-15/32" high x 8-1/2" deep (483 x 266 x 216 mm) (behind relay rack)
Weight..............Net, about 20 lb (9 kg); shipping about 24 lb (11 kg)

4398-M-A30 SEVEN-DIAL DOUBLE RATIO SET FACILITY

Line Power Input....120 volts, 50/60 Hz, 18 watts
Line Cord...........Three-wire (third wire ground), approximately 6 feet long, terminating in three-prong plug with grounding lug. Adapter to two-prong plug included
Cabinet.............Metal, finished in a durable, light-gray baked enamel with lifting handles. Designed for convenient operation from a sitting position. Top panel is tilted toward the operator to give a direct view with a minimum of annoying reflections. Lower panel slopes away from the operator to facilitate operation of knobs and keys. Vinyl dust cover included (095128)
Components..........Pre-wired facility contains:
4398-M-1 Seven-Dial Double Ratio Set
9828-1 D-C Null Detector
Dimensions..........22-3/16" wide x 27-3/16" high x 18-5/16" deep (564 x 691 x 465 mm)
Weight..............Net, about 110 lb (50 kg); shipping about 125 lb (57 kg)

4398-M-A31 SEVEN-DIAL DOUBLE RATIO SET FACILITY

Specifications same as 4398-M-A30 except: Line Power Input...120 volts, 50/60 Hz, 50 watts *and*

Components..........Pre-wired facility contains:
4398-M-1 Seven Dial Double Ratio Set
9828-1 D-C Null Detector
9876-M-1 D-C Power Supply

OPTIONS

-B Suffix: L&N Report of Calibration
At the time of calibration, resistance ratio values obtained by use of the equation and corrections given are not in error by more than 0.001%

-R Suffix: Provision for remote electrical (sequential) readout.
Field Note: For automated readout accessories, refer to EIC

ACCESSORIES RECOMMENDED

LIST NO.	DESCRIPTION	QUANTITY DRS	 DRRS
9828, 9828-1	D-C Null Detector	1	1
056001 or	No. 6 Dry Cell, 1.5 Volts	3	10
9876-M-1 or	Line-Operated DC Power Supply (0-100 Volts)	1	1
056065 or	"B" Battery, 22.5 Volts	1	2
7597	Willard Low Discharge Storage Cell, 2-Volt	1	
4030-B	NBS Type Resistance Standard, 100-Ohms	11	11
127287	Mercury Stands	12	10
128436	Copper Shorting Links	1	1
128488	Amalgamated Binding Post Terminals		2
--	Battery Rheostat, Approx. 15 ohms, 10 amp, dc	1	
4035-B	NBS Type Resistance Standard, 1000-ohms	2	2

4393-2 SIX-DIAL UNIVERSAL RATIO SET

A wide range ratio set for use in the d-c calibration of precision potentiometers and resistance standards including odd value resistors. It can also serve as: a microvolt potentiometer for comparing reference voltage sources such as standard cells; a Five-Dial Direct Reading Ratio Set; and a Six-Dial Precision Resistance Box.

SPECIFICATIONS

Total Nominal Resistance...2111.11

Adjustable Range..........When used as a Universal Ratio Set:

20 x 100 + 10(10 + 1 + 0.1 + 0.01 + 0.001) ohms

When used as a Five-Dial Direct Reading Ratio Set:

Nominal ratios of 1/1, 5/1, and 10/1. Adjustable arm can be varied from 944.445 to 1055.555 ohms for a range of approximately ±5.5%. Resolution is ±1 ppm.

Limits of Error...........When used as a Universal Ratio Set (at 25 C):

(a) 0.002% for ratio settings involving one or more steps on the 100 dial above the zero position

(b) For ratio settings involving changes in dial settings either below 100 or above 2000, the accuracy of reading is within two steps on the 0.001 dial

When used as a Direct Reading Ratio Set:

For comparisons by the direct or double substitution method, limit of error is 1 ppm providing the standard resistor and the resistor under test are alike to within 0.1% Limit of error increases to 2 ppm at differences of 0.5% and 5 ppm at differences of 5.5%.

For normal comparison, not involving the above techniques, the limit of error approaches 1 ppm when the ratio in use is calibrated as described in L&N Directions supplied with the instrument (D.B. 3070).

Optional Use..............Six-dial precision resistance box, range 0 to 2111.11 ohms

[(20 x 100) + 10(10 + 1 + 0.1 + 0.01 + 0.001)]

The change of each step above the zero residual is the nominal value ±(0.01% + 0.005) ohms. The residual zero resistance will not exceed 0.02 ohm

Range Extension...........Ratios of 10/1 or 1/10 can be applied to any dial setting (two 19,000-ohm resistors, one at each end, introduced by plug and block arrangement). Resolution is also increased by a factor of 10 since the full resolution of 4393-2 dials is applied to 10% of the range. The limit of error of the factor 10 used in extending the range is ±100 ppm

Calibration...............Direct calibration checks of the five lower decades (10, 1, 0.1, 0.01, 0.001) can be made when the entire 20 x 100-ohm-switch-resistance is shorted out (accomplished by step selection). Maximum variation between each step will not exceed 0.002 ohm

Switches..................The five lower decades are L&N type 31-3 totally enclosed silver alloy switches having sustained low contact resistance and low thermal emf. Parallel contact design assures reproducibility of contact resistance of better than 0.0003 ohm per decade

Applied Voltage...........Usually 2 to 4 volts is sufficient, but up to 50 volts may be applied if permitted by apparatus under test.

Internal Structure........All resistors enclosed in thermal equalizing chamber. Thermometer on top plate indicates chamber temperature.

Case and Cover............Metal top plate and case provide electro-static shielding. Metal case lined to provide additional thermal shielding. Metal dust cover protects instrument when not in use.

Physical Details..........Designed for table mounting. 24" wide, 8-1/2" high, 10" deep (610 x 216 x 254 mm)

Weight....................Net, about 37 lb (17 kg); shipping about 47 lb (21 kg)

OPTIONS

-B Suffix...L&N Report of Calibration. At the time of calibration, resistance changes obtained by the use of the supplied data are not in error by more than 0.001% for changes of 100 ohms or more, nor by more than 0.001 ohm for smaller changes.

ACCESSORIES RECOMMENDED

Field Note: *For calibrating L&N potentiometers and bridges, see specific instruments for Equipment Required For Customer Calibration.*

GENERAL

9828 or	Electronic D-C Null Detector
2430-c	Type E Galvanometer
127272	Pair of Nylon-Covered Brackets for 60° slope-mounting of instrument

COMPARING STANDARD CELLS (4393-2 USED AS A POTENTIOMETER)

7311	Standard Cell, Saturated. *See also 7308 Unsaturated Standard Cell*
7596	Battery, Willard Low Discharge, 6 volts
--	Variable Resistor. Approximately 4000-ohms. Should be of manganin and adjustable to 0.001 ohm in order to permit adjustment of the potentiometer current to the 4393-2. *Consult EIC.*
3294	DPDT Pinch-Type Switch. All copper construction
—	Key *Consult EIC.*

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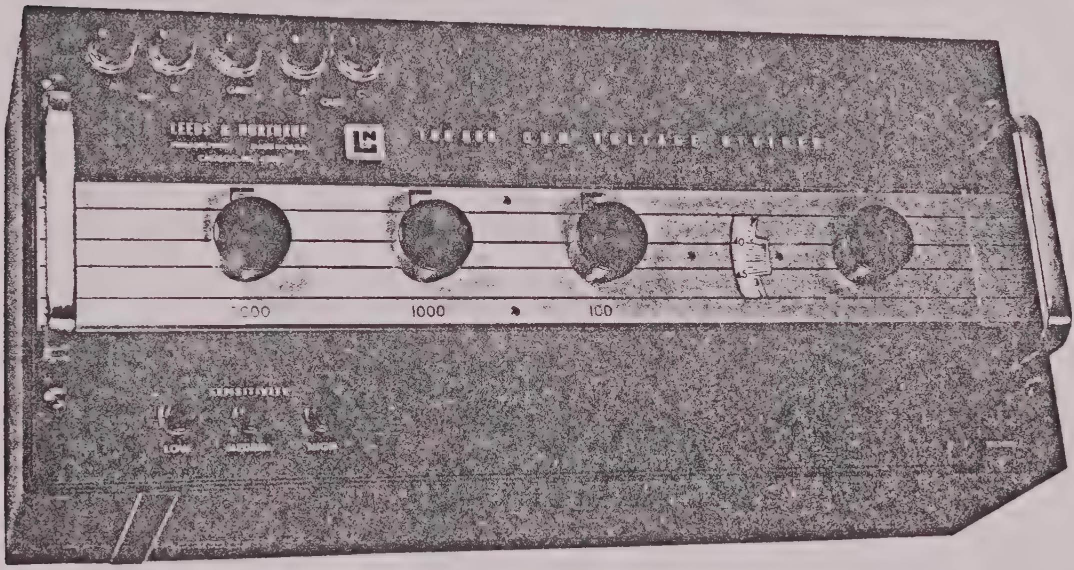


L&N Photo No. 41836

4395 PRECISION VOLTAGE DIVIDER

ADVANTAGES

- Suitable for a-c, up to 1000 cycles, as well as d-c applications
- Easy to read...reduces possibilities of reading errors
- High resolution...1 ppm
- Totally enclosed L&N Type 31 Switches have low, stable contact resistance
- May be used as a calibrated potentiometer by assigning voltage values to the dial units

FEATURES

- In-line digital readout of decades...window with each dial
- Metal case and top plate...electrostatic shielding
- Acrylonitrile-insulated binding posts

4395 PRECISION VOLTAGE DIVIDER FOR TABLE TOP USE

APPLICATION

Principal applications include measurement of an unknown voltage, d-c or a-c (up to 1000 cps), calibration of a slidewire, and standardizing a larger, adjustable voltage with respect to a smaller, accurately-known, standard voltage; particularly useful in checking linear and non-linear slidewire potentiometers.

SPECIFICATIONS

Function.............Divides input voltage to provide an output voltage that can be adjusted in 0.001% steps of the input voltage.
Max. Input Voltage....D-C: 200 V continuous (or 300 V for 30 minutes)
A-C: 200 V continuous (or 300 V for 30 minutes), up to 1000 cps.
Input Resistance......100,000 ohms ±0.1%.
Decade Switches.......Three, each adjustable in nine fixed steps. Steps are 10000 for first switch, 1000 for second switch, and 100 for third switch.
Slidewire............Continuously adjustable from 0 to 100 ohms; scale has 100 major divisions each of which is subdivided by two (5 ppm). Resolution 1-ppm
Accuracy of Adj.......±1 major slidewire-scale division for any setting of switches and slidewire from 1 to 100,000.
Keys.................High, medium, and low for connecting sensitivity resistors in series with external galvanometer or other null-balance detector.
Binding Posts.........Two input, two output, and case ground. Acrylonitrile-insulated.
Case.................Aluminum top plate and extruded aluminum case with handles, feet and vinyl dust cover. Provides electrostatic shielding
Dimensions...........19-1/4" wide x 9" high x 5-5/8" deep (489 x 229 x 143 mm); 7-7/16" (189 mm) deep including feet and handles.
Weight...............Net, about 12 lb (5.4 kg); shipping, about 16 lb (7.3 kg)

4395-1 PRECISION VOLTAGE DIVIDER FOR 19" RELAY RACK MOUNTING

Specifications same as 4395 except:
Case.................Sheet metal, for 19" (483 mm) relay rack mounting
Dimensions...........19" wide x 9" high by 5-5/8" (483 x 229 x 143 mm) behind relay rack

OPTIONS

-B Suffix	L&N Report of Calibration Values obtained by application of the corrections to the individual dial and slidewire settings or the summation of any combination thereof are correct within 0.5 dial unit (5 PPM).

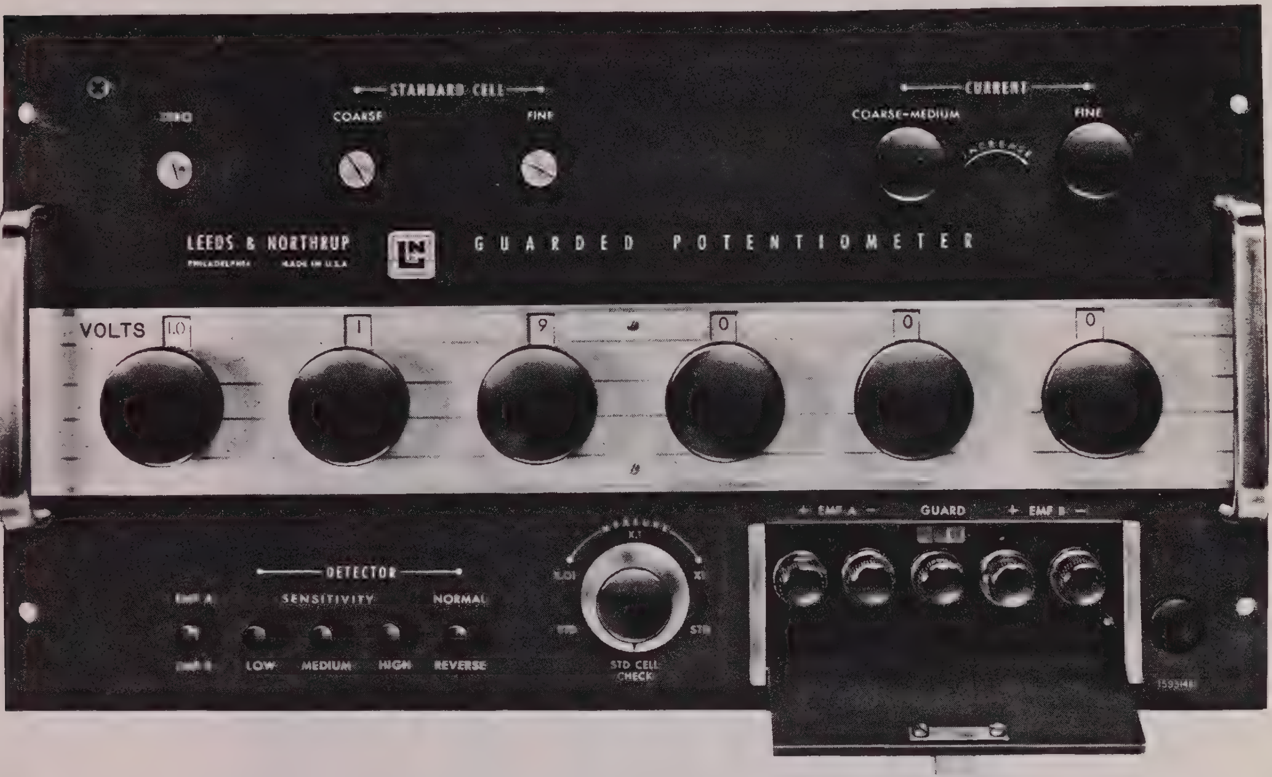
ACCESSORIES RECOMMENDED

9828 or	Electronic D-C Null Detector
2340-d or	Pointer Galvanometer For D-C Applications. Sens: 0.1 µA/mm *(For total applied voltages of 100 volts or greater)*
2435-d	Reflecting Galvanometer For D-C Applications. Sens: 0.01 µA/mm *(For less than 100 volts applied)*
7308	Unsaturated Standard Cell *Recommended for d-c applications when an adjustable input voltage is to be standardized.*
124179	Slidewire Cleaner and Lubricant

EQUIPMENT REQUIRED FOR CUSTOMER CALIBRATION OF 4395 AND 4395-1

The instrument should be checked before it is put into service and at intervals of six months. Environmental shocks or wide fluctuations of any sort require a check to be made even though the regular interval has not elapsed.

4393	Six-Dial Universal Ratio Set	3702	Tapping Key
4045-B	N.B.S. D-C Resistance Standard, 100,000 Ohms	056001	No. 6 Dry Cell, 1.5 Volt
9828	Electronic D-C Null Detector	—	Solid Copper Clip Connector, Mueller Electric Co. #45C with #47 Insulator
4775	Resistance Box. Two Required	177340	Direction Book: Calibration Procedure


STANDARD CELL
COARSE
FINE
CURRENT
COARSE-MEDIUM
FINE
INCREASE
LEEDS & NORTHRUP
PHILADELPHIA
MADE IN U.S.A.
GUARDED POTENTIOMETER
VOLTS
1.0
1
9
0
0
0
DETECTOR
SENSITIVITY
NORMAL
LOW
MEDIUM
HIGH
REVERSE
EMF A
EMF B
STD CELL CHECK
X.1
X.01
X1
STD
EMF A
GUARD
EMF B

L&N Photo No. 39194-a

7556 TYPE K-6 GUARDED POTENTIOMETER

ADVANTAGES

- Highest accuracy presently available
- Freedom from electrostatic effects
- Convenient to install and operate

FEATURES

- Battery, detector and standard cell circuits are individually guarded
- Metal case and top plate...electrostatic shielding can be provided
- Thermal Equalizing Chamber houses all resistors, key, and switches
- Matched resistors...constructed from a single length of Grade A Manganin wire
- Superior version of L&N Type 31 Enclosed Silver-Alloy Switches
- Pin terminals on rear terminal panel for calibration purposes
- Gold-plated copper terminals, guarded type
- In-line digital readout...windows above each dial

Precision Potentiometers
TYPE K

7556-A☐ TYPE K-6 POTENTIOMETER FACILITY

ADVANTAGES

- Highest accuracy
- Ready to plug in and use...set up time eliminated
- Matched components, factory wired
- Convenient to operate

FEATURES

- Self-contained, compact cabinet with lifting handles
- Potentiometer panel slopes away from operator...facilitates operation
- Detector panel slopes toward operator for direct view and glare reduction
- Null Detector is large...easily read...fast response, short period
- Function switch permits voltage output for remote recording
- Potentiometer features...see other side

SIX DIAL GUARDED PRECISION POTENTIOMETER

7556-1	**FOR 19" RELAY RACK MOUNTING**
7556-A32	**FACILITY, With 9828-1 Null Detector And 9878 Guarded D-C Constant Voltage Supply**
7556-A33	**FACILITY, With 9838-1 Nanovolt Detector and 9878**
7556-A34	**FACILITY, With 9829-1 Linear Amplifier**

DESCRIPTION

7556-1	A guarded, precision instrument for making emf measurements from 0 to 1.6 volts with the highest accuracy available.
-A32, -A33, -A34	A completely packaged and prewired facility for making emf measurements from 0 to 1.6 volts with the highest accuracy.

APPLICATION

Meets the most exacting requirements of standardizing, research and testing laboratories. Particularly useful for precise temperature measurements in studies of specific heats, melting and boiling points, etc. (Using thermocouples and resistance thermometers); for standard cell checking and calibration; for measuring resistance by comparison; and for calibrating less precise potentiometers. Also used for precise measurements in a wide variety of applications such as calorimetry, cryogenics, pH studies, and electrical potentials from a variety of electrodes, transducers and detectors.

SPECIFICATIONS	General, for 7556-1 and all suffixes
Ranges	High (X1) 0 to 1.6 volts in steps of 1 microvolt Med. (X.1) 0 to 0.16 volt in steps of 0.1 microvolt Low (X.01) 0 to 0.016 volt in steps of 0.01 microvolt
Limits of Error of Potentiometer	High range ±(0.0005% of reading +1 μV) Med. range ±(0.0015% of reading +0.1 μV) Low range ±(0.0025% of reading +0.02 μV)
Power Supply	Requires 11 milliamps, battery voltage 1.8 to 2.16 volts
Internal Res.	As seen by detector, and exclusive of external resistance, approximately 10 to 220 ohms, depending on setting of dials
Guarding	Battery, detector, and standard cell circuits individually guarded, to intercept leakage currents, assuring accurate measurements even in relatively high humidity ambients
Shielding	Metal case and top-plate may be grounded to provide electrostatic shielding
Thermal Lagging	All principle resistors of potentiometer circuit are enclosed in an inner metal box to provide a constant temperature environment. The outer box is lined with thermal insulation as a further precaution.
Thermal EMF	Generated by operation of switches is considerably less than 0.1 μV thermal emf and of only momentary duration. Other thermals in measuring circuit are less than 0.02 μV when instrument is acclimated for at least 8 hours in an ambient between 23 and 27 C and varying at a rate not exceeding 0.5 C in 4 hours.
Function Switch	Provides for following operations; Measure X1, Measure X.1, Measure X.01, Standardize and Standard Cell Check. For maximum accuracy the potentiometer should be standardized in the Standard Cell Check position. Use of the Standard positions may introduce an additional error of about 0.0001% (1 ppm).
Zero Trimmer	With all potentiometer dials on zero, trimmer may be adjusted to balance out any residual thermals. Resolution is better than 0.1 ppm
Two EMF's	Two pairs of binding posts provided for connecting two emf's, selected by EMF A - EMF B key. Recessed; front access door shields terminals.
Binding Posts	All binding posts are of acrylonitrile-insulated gold-plated copper. Terminals for battery, detector and standard cell are located on rear panel.
Calibration	Terminals provided on rear panel for recalibrating potentiometer, either by user, the Bureau of Standards or a calibration laboratory. Directions are available from L&N for this purpose.
Detector Keys	Selection provided by tap keys to obtain sensitivities of 1/400, 1/20 and 1 times the sensitivity of the detector used. "Normal-Reverse" key for detector also provided to isolate residual thermals from detector circuit.
Standardization	Provided by one "Coarse-Medium" knob and one ten-turn "Fine" knob. Resolution better than 0.1 ppm.
Std. Cell Adj.	Utilizes main potentiometer dials to set standard cell value. "Coarse" and "Fine" standard cell adjustments protected by cap screws against accidental maladjustment. Resolution better than 0.1 ppm.
Switches	All switches are an improved version of the L&N Type 31 totally enclosed, with silver alloy contacts. Special brush and contact arrangements result in high stability of contact resistance.
Resistors	All resistors are bifilar wound using L&N Grade A manganin wire on ceramic spools. Wattage rating is 250 milliwatts (maximum wattage requirement in circuit is one milliwatt). Temperature coefficients are less than 10 ppm/C over a range of 20 C to 35 C.
Keys	All keys have gold contacts; thermal-free, guarded construction

(More)

FOR GUARDED PRECISION POTENTIOMETER

SPECIFICATIONS (Continued)

7556-1 TYPE K-6 GUARDED POTENTIOMETER FOR 19" RELAY RACK MOUNTING

Case...............Metal, Gray, for 19" relay rack mounting
Dimensions..........19'W x 10-15/32"H x 7-1/2"D (483 x 266 x 190 mm) (behind relay rack)
Weight..............Net, about 32 lb (14.5 kg); shipping, about 41 lb (19 kg)

7556-A32 TYPE K-6 POTENTIOMETER FACILITY

Line Power Input....120 volts, 50/60 Hz, 10 watts
Line Cord...........Three-wire (third wire ground), approximately 6 feet long, terminating in three-prong plug with grounding lug. Adapter to two-prong plug included.
Cabinet.............Metal, finished in durable, light-gray, baked enamel with lifting handles. Designed for convenient operation from a sitting position. Top panel is tilted toward the operator to give a direct view with a minimum of annoying reflections. Lower panel slopes away from the operator to facilitate operation of knobs and keys. Vinyl dust cover (095128) included.
Dimensions..........22-3/16" wide x 27-3/16" high x 19" deep (564 x 691 x 483 mm)
Weight..............Net, about 85 lb (39 kg); shipping, about 110 lb (53 kg)
Components..........Prewired facility includes:
7556-1 Type K-6 Potentiometer
7308 Unsaturated Standard Cell *(See Field Note)*
9878 D-C Constant Voltage Supply
9828-1 D-C Null Detector (Sens. 0.067 μV/mm)

7556-A33 TYPE K-6 POTENTIOMETER FACILITY

Same as 7556-A32 except:

Line Power Input....120 volts, 50/60 Hz, 10 watts
Components..........Same as 7556-A32 except has:
9838-1 Guarded D-C Null Detector (sens. 0.01 microvolt/div.) in place of 9828-1

7556-A34 TYPE K-6 POTENTIOMETER FACILITY

Same as 7556-A32 except:

Line Power Input....120 volts, 50/60 Hz, 10 watts
Components..........Same as 7556-A32 except has:
9829-1 Linear Amplifier (in place of 9828-1)

OPTIONS

-B Suffix...........L&N Report of Calibration. Using the corrections shown on these reports, the potentiometer limits of error at 25 C are:

High Range	(X1)	±(0.0003% of reading +0.5 μV)
Med. Range	(X.1)	±(0.0010% of reading +0.05 μV)
Low Range	(X.01)	±(0.0015% of reading +0.01 μV)

-R Suffix...........Provision for sequential readout. Connections from switches are brought out to a connector on back panel.

TYPE K-6 GUARDED PRECISION POTENTIOMETER (Continued)

ACCESSORIES

Recommended for 7556-1 *See Field Notes below*

7597	Two-Volt Storage Cell; 200 ampere-hours or
9878	Guarded D-C Constant Voltage Supply
7308	Unsaturated Standard Cell *(See Field Note)*
9838-1	Guarded Nanovolt D-C Null Detector or
9828-1	Guarded Electronic D-C Null Detector

OPTIONAL ACCESSORIES

127272	Pair of Nylon-Covered Brackets, for 60 degree slope-mounting of potentiometer
124179	Cleaner-Lubricant For Slidewire
7582	Volt Box; 300 volts maximum
7592	Volt Box; 750 volts maximum
7593	Volt Box; 1500 volts maximum
4385	Shunt Box For Current Measurements: 15 amperes maximum
7311	Saturated Standard Cell. For use as primary voltage reference

EQUIPMENT REQUIRED FOR CUSTOMER CALIBRATION

177347	Directions For Calibrating Six-Dial Precision Potentiometer
4393-2	Six-Dial Universal Ratio Set
9838	Guarded Nanovolt D-C Null Detector or
9828	Guarded Electronic D-C Null Detector
056001	No. 6 Dry Cell, 1.5 volts. Three required, series connected.

FIELD NOTES ON 7556 POTENTIOMETER ACCESSORIES, FACILITIES

Standard Cell.....Unsaturated standard cells, such as the 7308, have voltages between 1.0188 and 1.0196, internal resistance of less than 500 ohms, and temperature coefficients of about -3 μV per degree C. The certificates supplied with them indicate the voltage to the nearest 0.001 accurate to 0.005% (50 ppm). Because of the latter, the full accuracy potential of the 7556 can best be realized if calibrated, periodically against a saturated standard cell maintain as a laboratory standard.

Saturated standard cells have voltages of approximately the same value as the unsaturated type, but are certified to the nearest 0.1 μV, accurate to 1 μV. However, they have temperature coefficients of about -40 μV per degree C and must therefore be temperature controlled to about 0.01 C. They are normally supplied in banks of 3, 4 or 6 cells, with or without temperature controlled enclosures. They are available through L&N (e.g., 7311) or direct from the manufacturer.

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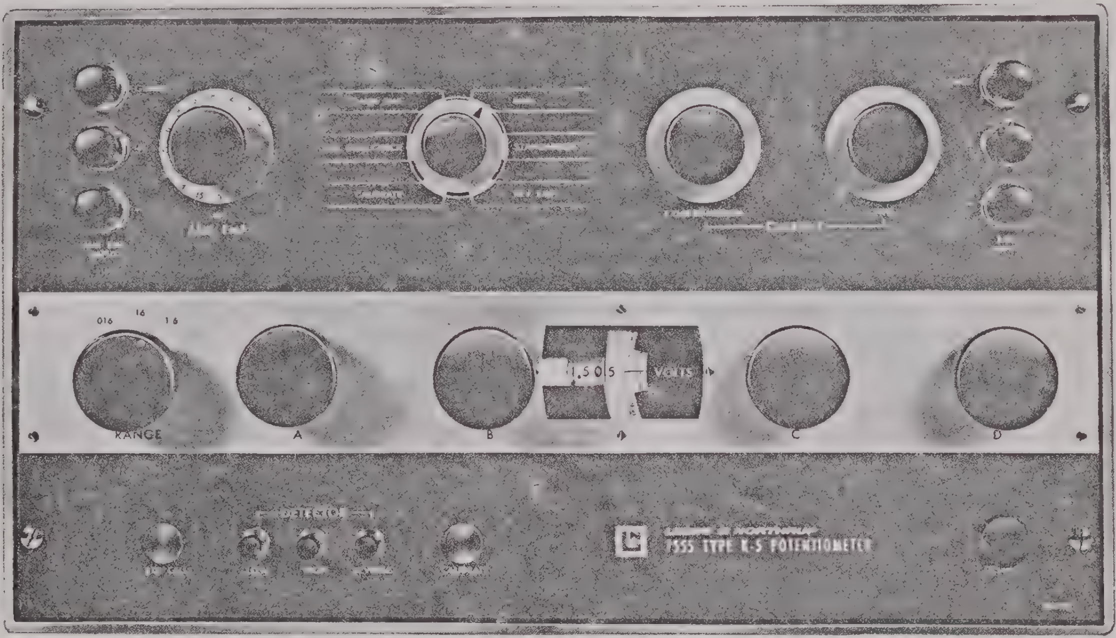


L&N Photo No. 44593-5

7555 TYPE K-5 UNIVERSAL GUARDED POTENTIOMETER

ADVANTAGES

- Resolution of 0.02 μv/division on low range
- Maximum convenience of operation and readout
- Convenient checking provisions
- Stable live zero through internal lead balance
- Small continuous changes may be easily followed
- Mounting versatility...bench, rack, or pre-wired facility

FEATURES

- Centralized display of numerical value with automatic decimal point placement
- Double hairline for improved interpolation
- Completely guarded
- Thermal and electrostatic shielding
- Double slidewire contact for thermal cancellation
- Function switch with polarity reversal and calibration provisions
- Auxiliary emf switch for measuring related emfs

TYPE K-5 UNIVERSAL GUARDED POTENTIOMETER

7555...........FOR BENCH USE
7555-1.........FOR 19" RELAY RACK MOUNTING
7555-A31.......FACILITY, Has 9828-1 Null Detector and 9879 Power Supply
7555-A32.......FACILITY, Has 9838-1 Nanovolt Null Detector and 9879 Power Supply

DESCRIPTION

7555 and -1.......A guarded direct-reading, high precision potentiometer for general use

-A31.............A completely packaged pre-wired facility for making rapid and accurate d-c potential measurements in research, standardizing and testing laboratories.

APPLICATION

For emf measurements from 0 to 1.6 volts with high accuracy. Particularly useful for precise temperature measurements in studies of specific heats, melting and boiling points, etc., (using thermocouples and resistance thermometers); for standard cell checking and calibration; for measuring resistance by comparison; and for calibrating less precise potentiometers. Also for precise measurements in a wide variety of applications such as calorimetry, cryogenics, pH studies, and electrical potentials from a variety of electrodes, transducers, and detectors.

SPECIFICATIONS....General, for 7555 and all suffixes

Ranges...........1.6 (High): -50 μV to +1.611050 volts
0.16 (Medium): -5 μV to +0.1611050 volt
0.016 (Low): -0.5 μV to +0.01611050 volt

Limits of Error...1.6 (High Range): ±(0.003% of reading +3 μV)
0.16 (Medium Range): ±(0.005% of reading +0.3 μV)
0.016 (Low Range): ±(0.005% of reading +0.1 μV)
Ranges 1.6 and 0.16 for "A" dial settings other than zero

Measuring Dials...A Switch: 15 X 0.1 volt
(Voltages shown for high range)
B Switch: 10 X 0.01 volt
C Switch: 10 X 0.001 volt
D Slidewire: One turn, 550 divisions -50 μV to +0.001050 volt. Slidewire is provided with a detent mechanism producing 110 discrete numbered steps of 10 μV per step. By disengaging the detent mechanism (knob controlled), 2 μV subdivisions may be read and 1 μV estimated. (slidewire resolution is 0.5 μV)

The "D" knob has an approximately 4:1 gear ratio with the slidewire to facilitate positioning the slidewire to any desired setting.

Thermal EMF.......Transient thermals are less than 0.1 microvolt during normal operation of switch and less than 0.1 microvolt within 1 second after normal operation of slidewire

Detector Keys.....Selection is provided by means of tap keys to obtain either full sensitivity of the detector used or a reduction of 1/400.
A normal-reverse key for the detector is also provided to isolate residual thermals within the detector circuit.

Internal Res......Resistance of potentiometer as measured across the emf input terminals varies from approximately 10 to 280 ohms, depending on dial settings

Power Supply......Requires 12.1 milliamperes from 1.8 to 2.2 volts d-c supply

Standardization...Provided by one "Coarse-Medium" rheostat and one ten-turn "Fine" rheostat. Resolution is better than 0.5 ppm.

Std. Cell Adj.....Utilizes main potentiometer dials to set standard cell value. Adjustment protected by cap screw against accidental maladjustment. Resolution is better than 0.3 ppm for standard cells in the range of 1.0175 to 1.0205 volts.

Switches..........All switches are an improved version of the L&N Type 31, totally enclosed, with silver alloy contacts. Special brush and contact arrangements result in high stability of contact resistance.

Function Switch...Provides for following operations:
AUX EMF, EMF, STANDARDIZE, REV EMF, CALIBRATE, and STD CELL CHECK

Range Switch......Provides for selection of three ranges: 1.6 (X1), 0.16 (X0.1), and 0.016 (X0.01)

Keys..............All keys have gold contacts and are of thermal-free, guarded construction

Binding Posts.....Guarded type with low thermal, gold-plated copper terminals and acrylonitrile styrene copolymer insulation. Accommodate wire sizes up to 14 AWG. Binding posts are located on rear panel. Duplicate emf "+", "-", and "Guard", plus auxiliary emf "+", "-" and "Guard" terminals are located on the front panel.

Guarded Circuits..Battery, standard cell and detector circuits are guarded to intercept leakage currents thus assuring accurate measurements, even under high humidity conditions

Aux Emf Circuit...Auxiliary emf terminals and a 16 position decade switch (steps equal to "A" switch) for wattmeter calibration and other measurements of different but related emfs

Self-Calibration..Potentiometer zero and relationship of B dial to A dial may be precisely checked and adjusted, if necessary. Circuitry also permits precise measurement of relationship between A dial resistors using an auxiliary potentiometer.

(More)

UNIVERSAL GUARDED POTENTIOMETERS

SPECIFICATIONS

7555 TYPE K-5 POTENTIOMETER FOR BENCH USE

Case.................Cast aluminum, with vinyl dust cover. Case is provided with retractable legs permitting two position mounting. Normal position inclines top plate at an angle of 30 degrees with the horizontal. With legs extended, the top plate is inclined at an angle of 50 degrees with the horizontal.

Dimensions..........19-1/4" w x 11" h x 9-1/2" d (489 x 279 x 241 mm) with legs retracted; 11-3/8" d (289 mm) with legs extended

Weight...............Net, about 33 lb (15 kg); shipping, about 36 lb (16.3 kg)

7555-1 TYPE K-5 UNIVERSAL GUARDED POTENTIOMETER FOR RELAY RACK MOUNTING

Case.................Sheet metal case for 19" relay rack mounting

Dimensions..........19" wide x 10-15/32" high x 8-1/2" deep (483 x 266 x 216 mm) (behind relay rack)

Weight...............Net, about 22 lb (10 kg); shipping, about 25 lb (11.3 kg)

7555-A31 TYPE K-5 POTENTIOMETER FACILITY

Line Power Input.....120 volts, 50/60 hertz, 24 watts

Line Cord...........Three-wire (third wire ground), approximately 6 feet long, terminating in three-prong plug with grounding lug. Adapter to two-prong plug included

Cabinet.............Metal, finished in a durable, light-gray baked enamel with lifting handles. Designed for convenient operation from a sitting position. Top panel is tilted toward the operator to give a direct view with a minimum of annoying reflections. Lower panel slopes away from the operator to facilitate operation of knobs and keys. Vinyl dust cover included (095128).

Components..........Pre-wired facility contains:

7555-1 Type K-5 Potentiometer
9828-1 D-C Null Detector
7308 Unsaturated Standard Cell
9879 Constant Voltage Supply

Dimensions..........22-3/16" wide x 27-3/16" high x 18-5/16" deep (563 x 691 x 465 mm)

Weight..............Net, about 110 lb (49 kg); shipping, about 125 lb (57 kg)

7555-A32 POTENTIOMETER FACILITY

Specifications.......Same as 7555-A31 except,

Components..........Facility contains:

7555-1 Type K-5 Potentiometer
9838-1 Nanovolt Null Detector
7308 Unsaturated Standard Cell
9879 Guarded Constant Voltage Supply

OPTIONS

-B Suffix......L&N Report of Calibration. Using corrections shown on these reports, the limits of error at 25 C are:

1.6 High Range: ±(0.001% of reading +2 μV
0.16 Medium Range: ±(0.003% of reading +0.2 μV
0.016 Low Range: ±(0.003% of reading +0.1 μV

-C1 Suffix.....*For 7555-A31.* 16-Position, 2-Pole Selector Switch (for use when checking thermocouples or other multiple EMF inputs). Switch mounted on right side of panel, marked 0 through 15 and wired to 32-point terminal board accessible at rear of console. Terminal board marked + and − and numbered 0 through 15. Switch collectors (two) connected to the EMF + and − binding posts of potentiometer. See section 10.3-3-3.

ACCESSORIES

Recommended for 7555 and 7555-1

9879...........Precision Guarded Constant Voltage Supply

7308...........Eppley Unsaturated Standard Cell

9828-1.........Null Detector
or
2430-A.........Type E Guarded Galvanometer

20-36-5........Guarded Leads, ________ft. 20 gage, two conductor, standard copper wire with polyethelene insulation, conductive vinyl shield with bleeder wire, and pvc outer insulation

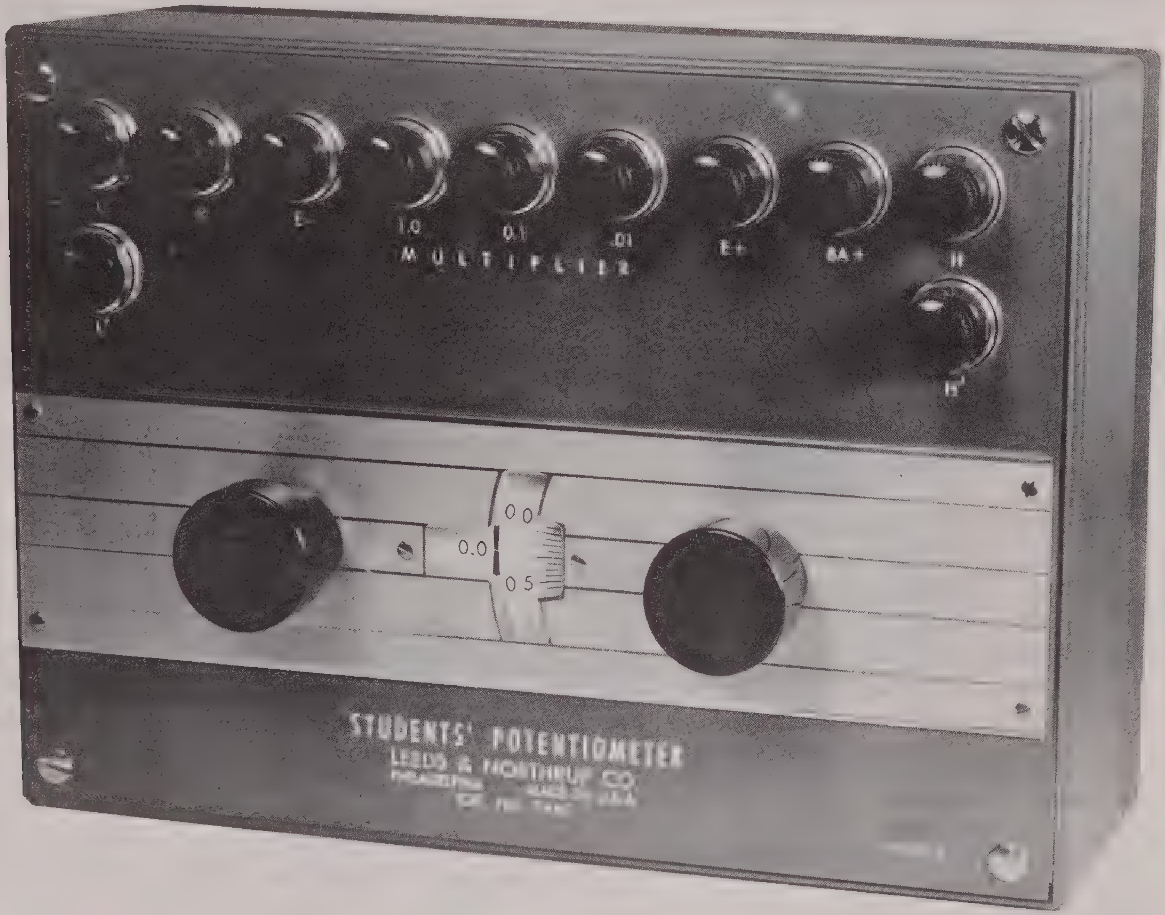
OPTIONAL ACCESSORIES

124179	Cleaner-Lubricant for slidewire
7582	Volt Box, 300 volts maximum
7592	Volt Box, 750 volts maximum
7593	Volt Box, 1500 volts maximum
4385	Shunt Box, 15 amperes maximum

APPLICATION OF HIGHER VOLTAGE POWER SUPPLY FOR RANGE EXTENSION OF 7554 AND 7555 POTENTIOMETERS

Range Extension.........	3.2 volt level	16 volt level
Power Requirements......	3.6 to 4.6 volt power supply (two 2-volt batteries in series) capable of delivering 24.2 mA to POWER SUPPLY terminals	18 to 23 volt power supply capable of delivering 121 mA to POWER SUPPLY terminals
Readings..............	Multiplier of "2" must be applied to readings. *Also applies to the AUX EMF voltages as well as the EMF voltage readings when using the* **K-5**.	Multiplier of "10" must be applied to readings. *Also applies to the AUX EMF voltages as well as the EMF voltage readings when using the* **K-5**.
Standardization.........	Requires two standard cells connected in series to the STD CELL terminals. Set the volt dials to the average voltage of the two cells when using the STD CELL CHECK position	Can be accomplished in the EMF position with cell connected to the EMF terminals
Limits of Error.........	Same limit of error when extending the voltage range to 3.2 volts as for 1.6 volt	On 16 volt range for **K-4**: ±(0.009% + 200 μV) On 16 volt range for **K-5**: ±(0.007% + 30 μV) The limits of error for the 0.16 and 1.6 volt ranges remain as given for these ranges in the standard specs

Precision Potentiometers
STUDENTS' POTENTIOMETERS



L&N Photo No. 44532-2

7645 STUDENT'S POTENTIOMETER

ADVANTAGES

- Circuit is simple...designed to demonstrate the potentiometer principle
- Eliminates periodic cleaning of brushes and contact studs...enclosed switch
- Negligible thermal emfs on switching...switch assembly of a type used in advanced precision instrumen
- Centralized digital display...easy to read
- Wide application...Directions cover measurements of voltage, current, temperature; calibration of voltmeters, ammeters, wattmeters, and potentiometers; and Wheatstone Bridge applications.
- Working accessories easily connected by the student

FEATURES

- Totally enclosed construction
- Metal case and top plate...electrostatic shielding
- L&N Type 31-3 high quality Enclosed Silver, Silver-Alloy Rotary Switches
- Independent slidewire end-point connections for Wheatstone Bridge applications
- Central reading window, single row of digits plus a scale interpolation

EQUIPMENT REQUIRED FOR CUSTOMER CALIBRATION OF 7592 AND 7593

The volt box should be checked at intervals of every six months if in regular use.

FOR HIGHEST ACCURACY

7594...............Guarded Standard Volt Box. NBS Report of Calibration states ratio values to an accuracy of 10 ppm.

FOR WIDE APPLICATION

Directions Book completely covers procedure for using following:

4035-B ....1000-Ohm NBS Type Resistance Standard
4040-B ....10,000-Ohm NBS Type Resistance Standard
4045-B ....100,000-Ohm NBS Type Resistance Standard

4393 ....Universal Ratio Set
9828 ....Electronic D-C Null Detector

056001 ....No. 6 Dry Cell, 1.5 Volt
056011 ...."B" Battery, 45 Volt
-- ....Autotransformer, 115 PRI, 0-130 V Sec., 2A. General Radio Type W2MT
-- ....Step-Up Transformer, TRIAD P-7A or Chicago-Standard PC-8304
-- ....3-Pole DT Switch (high quality insulation), L&N Co. Special Item
-- ....DPDT Shielded Battery Switch, L&N Co. Special Item
-- ....Test Clip, Mueller Elec. Co. No. 45-C with No. 47 Insulator

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SHUNT BOXES

ADVANTAGES

(1) Low, stable contact resistances and low thermal emfs
(2) Low power dissipation, reduces errors due to self-heating
(3) Easy to use
(4) Electrostatic shielding
(5) Bench type for "portability"

FEATURES

(1) High quality Type 31 Enclosed Silver, Silver-Alloy Selector Switches
(2) Metal case and top plate...electrostatic shielding
(3) Acrylonitrile-styrene-copolymer insulated binding posts

4385 SHUNT BOX FOR BENCH USE

A potentiometer accessory for the precise measurement of d-c current and for calibration of d-c ammeters and wattmeters.

SPECIFICATIONS

Range...............15 amperes maximum, 8 steps
Total Resistance....2.0 ohms
Output.. ....150 Millivolts for maximum current on each range
Limit of Error......±0.02% at 25 C
Function Switch.....

Max. Amps	Mult. By	Max. Amps	Mult. By
15	100	0.75	5
7.5	50	0.30	2
3	20	0.15	1
1.5	10	0.075	0.5

Binding Posts.......*LINE:* GRD, +; *POTENTIOMETER:* GRD, +
Case................Metal, with vinyl cover, 6-7/8" W x 6-1/2" L x 5-1/2" H (175 x 165 x 140 mm)
Weight..............Net, about 4 lb (1.8 kg); shipping, about 6 lb (2.7 kg)

L&N Photo No. 45536-14

4737-A21 GUARDED WHEATSTONE BRIDGE FOR PANEL MOUNTING

FEATURES

- Wide range: 0.1 ohm to 11,111 megohms
- In-line readout of all values
- Complete, compact measuring system...ready to use
  MOS-FET Detector: 1 μV sensitivity, continuously adjustable
  Guarded power supply (voltage varied by range switch from 1 to 50 volts)
- Useable resolution: 1 ppm from 100 ohms to 1 megohm
- Completely guarded and shielded
- Automatic voltage selection...prevents overheating
- Convenient calibration...no need to remove instrument from case
- May be used as a high accuracy, adjustable resistance box
- May be used as a limit bridge for product testing
- Provision for external detector or power supply connections...useful when greater sensitivity is desired, or bridge voltages other than those selected by multiplier dial are required

GUARDED WHEATSTONE BRIDGE		LINE POWER REQUIREMENTS	NULL DETECTOR AND POWER SUPPLY
	6-DECADE READOUT	--	Separately order: Guarded null detector of proper sensitivity for stated accuracy and power supply variable from 0 to 50 V.
4737	Bench Type	--	
4737-1	19" Relay Rack Type	--	
		--	
4737-A20	Bench Type Facility	120 V, 50/60 Hz	Internally mounted. Provision for connection of external guarded null detector for greater sensitivity for measurements below 100 ohms and above 1m, and external power supply for bridge voltages other than those selected by the range multiplier dial.
4737-A21	19" Rack Type Facility	120 V, 50/60 Hz	
4737-A22	Bench Type Facility	230 V, 50/60 Hz	
4737-A23	19" Rack Type Facility	230 V, 50/60 Hz	

APPLICATIONS

For two terminal resistance measurements from 0.1 ohm to 11,111 megohms when laboratory precision is required. Particularly useful in calibrating resistors on a productionline basis, performing critical laboratory experiments or making routine resistance measurements.

SPECIFICATIONS, GENERAL

	GUARDED WHEATSTONE BRIDGE 4737 SERIES
Range....................	0.1 ohm to 11,111 megohms
Keys.....................	Three Detector on-off, power supply on-off, and power supply normal-reverse
Multiplier Dial..........	Eleven position switch from 10^{-1} to 10^{9}. Ratio resistors vary from 0.01 ohms to 10 kΩ with 10 kΩ always in at least one bridge arm
Rheostat Switches........	Six decades in steps of 10 (1000 + 100 + 10 + 1 + 0.1 + 0.01) ohms
Limit of Error at Ref Conditions★	±(0.01% + 0.0005 ohm) up to 10 MΩ ± 0.02% from 10 MΩ to 100 MΩ ± 0.2% from 100 MΩ to 1111 MΩ ± 2% above 1111 MΩ
Current Rating...........	determined by highest decade in use: 0.35A; 0.035A; For 0.01 ohm: 3.5A; for 0.1 ohm: 1.1A; for 1 ohm: 0.35A; for 10 ohm: 0.11A; for 100 ohm: 0.035A; for 1000 ohm: 0.011A
Calibration Points.......	Five Teflon feed-through terminals on rear terminal plate provide accessible current and potential points for calibration purposes

(more)

★Reference conditions are: Ambient temperature: 25 ±1C; relative humidity less than 80%; and instrument to be calibrated on a one-year cycle. With an ambient temperature of 25 ±10C, limit of error values are derated 10 ppm/°C for each degree outside reference conditions.

ADDITIONAL SPECS REQUIRED FOR LIST NUMBER

	4737 AND 4737-1 *(BRIDGE ONLY)*
Maximum Applied Voltage................	Table is given on instrument top plate. Voltages listed are the highest which may be applied to the bridge without exceeding the given accuracy▲
Guarded Circuits..........	"X1" binding post, the detector "2" post, the null detector key, and the multiplier switch
Binding Post.............	Nine. On top plate: For unknown resistance, guard and ground. On back plate: For null detector, power supply and ground. Provision is also made for use of rheostat decades as an adjustable resistance box
Physical Data............	**4737** Bench Type: 19" l x 10-1/2" w x 9-1/2" h (483 x 267 x 241 mm) with legs retracted, 11" h (279 mm) with legs extended — Weight: Net about 24 lb (11 kg); shipping about 27 lb (12 kg) **4737-1** Rack Type: 19" l x 10-7/16" w x 8-3/8" d (483 x 265 x 213 mm) Weight: Net about 15 lb (6.8 kg); shipping about 18 lb (8 kg)

4737-A20 AND 4737-A21 BENCH AND RACK TYPE FACILITIES

Same as SPECIFICATIONS, GENERAL, for 4737 SERIES plus:

	4737-A20 BENCH TYPE FACILITY	**4737-A21 RACK TYPE FACILITY**
Components................	Guarded Wheatstone Bridge;Electronic Null Detector, MOS-FET, 1 μV sensitivity *(L&N 2437 type)*;Power Supply (guarded for Bridge Circuit) A compact facility having all components needed to make high accuracy measurements. The detector sensitivity keys are arranged so that together with the sensitivity adjustment for the detector, per cent limit type inspection checks or deviation measurements may be made of like valued resistors	
Maximum Applied Voltage...	Range switch automatically selects a bridge voltage which prevents the wattage dissipation in the unknown from exceeding 10 milliwatts in all positions	
Guarded Circuits..........	"X1" binding post, power supply, power supply terminals, power supply keys, and the multiplier switch	
Binding Posts.............	Ten. On top plate: for guard, ground and unknown resistance. On back plate: three for internal-external null detector option and three for internal-external power supply option	
Power Requirements........	120 volts, 50/60 Hz, 2 volt-amperes	
Dimensions................	Cast aluminum case for bench use. 19" l x 10-1/2" w x 9-1/2" h (483 x 267 x 241 mm) with legs retracted, or 11" (279 mm) high with legs extended	Sheet metal case, relay rack type. 19" l x 10-7/16" w x 8-3/8" deep (483 x 265 x 213 mm)
Weight....................	Net about 29 lb (13 kg); shipping about 33 lb (15 kg)	Net about 20 lb (9 kg); shipping about 24 lb (11 kg)

'Maximum applied voltage based on rheostat arm set at 1000 (ohms) minimum:

Range Ω	*Multiplier Setting*	*Max D-C Voltage*	*Range Ω*	*Multiplier Setting*	*Max D-C Voltage*
		4737,-1			**4737,-1**
0.1 - 1	10^{-1}	*1.5*	*100K - 1M*	10^{5}	*7.5*
1 - 10	*1*	*1.5*	*1M - 10M*	10^{6}	*7.5*
10 - 100	*10*	*5.0*	*10M - 100M*	10^{7}	*7.5*
100 - 1K	10^{2}	*7.5*	*100M - 1G*	10^{8}	*15*
1K - 10K	10^{3}	*22.5*	*1G - 10G*	10^{9}	*15*
10K - 100K	10^{4}	*12*			

OPTIONS... **4737 SERIES**

-B Suffix...L&N Report of Calibration. Using the corrections shown on these reports, the limits of error at 25 C are:

FOR 4737 SERIES

±(0.005% + 0.0005 ohms) up to 10 MΩ
±0.012% from 10 MΩ to 100 MΩ
±0.1% from 100 MΩ to 1000 MΩ
±1% above 1000 MΩ

-R Suffix...(For 4737 Series only) Readout option. Not necessary to specify parallel or special readout. Plug supplied with instrument enables user to wire plug for either serial or parallel readout. Consult EIC for information on available output devices.

-T Suffix...*(4737-A20 and -A21 only)*: Provides terminals for input to a recorder with 5-0-5 mV range for recording deviation measurements, etc.

ACCESSORIES RECOMMENDED (For 4736, 4737 & 4737-1 ONLY)

127272	Mounting Brackets, plastic coated. For 60 degree slope-mounting of 4736 on table or bench
056009 or	Burgess 22.5 volt dry cell. Two required together with power rheostat for varying bridge voltages
9876-M-1	Line-operated D-C Power Supply adjustable in two ranges from 0 to 10 and 0 to 100 volts
9828,9828-1	Guarded D-C Electronic Null Detector with 0.1 μV sensitivity
836012	Cable suitable for connecting an unknown resistor located several feet from the bridge when guarding and shielding are required. This cable consists of a pair of twisted, polyethylene insulated, untinned, stranded copper conductors with two conductive vinyl shields provided with drain wires and insulated from each other with polyethylene insulation. Outside diameter is 0.23 inch

EQUIPMENT REQUIRED FOR CUSTOMER CALIBRATION

Directions Book 177496 (for Cat. 4737 and suffixes)

Six Dial Double Ratio Set	Cat. 4398
Two each of the following NBS Type Resistance Standards	
10,000 ohm	4040-B
1,000	4035-B
100	4030-B
10	4025-B
One each of these resistance standards	
1 ohm	4020-B (NBS Type)
0.1 ohm	4221-B (Reichsanstalt Type)
0.01 ohm	4222-B (Reichsanstalt Type)
Electronic Null Detector	2437
Two Decade Resistance Boxes	4775
Three Mercury Cup Stands	Part No. 127287
Copper Link	Part No. 128436
Dry Cell 1.5 volts	056001

FIELD NOTES...ERROR ANALYSIS

Error Components **	4737 AND SUFFIXES			
	10^{-1} to 10^{-6}	10^7	10^8	10^9
	PPM of Reading	PPM of Reading	PPM of Reading	PPM of Reading
A arm	20	20	20	20
B arm	20	50	1500*	5000*
Rheostat (1K & 100Ω decades)	30	30	30	30
Temperature Coef (1 C change)	10	10	10	10
Stability (1 yr)	10	10	10	10
Self Heating (Max. Voltage)	10	70	70	70
Binding Post Resistance (Two posts)	0.0002Ω	—	—	—
Possible Error	0.0002Ω + 100ppm	190ppm	1640ppm	5140ppm

**These resistors are not closely adjusted because of the absence of accurate multi-megohm standards for verifying a smaller Possible Error. These ranges are checked using delta-wye transformations. (Ref. A.I.E.E. Transactions Paper 58-556).*

***Individual error components listed are worst case values based on random checks; however, since not every error component on every instrument is checked, the guarantee is for the Limits of Error listed in the Specifications under Reference Conditions.*

L&N Photo No. 24905

8067 TYPE G-1 MUELLER TEMPERATURE BRIDGE

ADVANTAGES

- Covers the entire range of 8160 and 8163 Platinum Resistance Thermometers
- Convenient to use
- Negligible contact resistance error...switches and series resistors shunted with low resistance
- Provision for optional external zero correction for measurements of greatest precision
- Low cost

FEATURES

- May be used with resistance thermometer bulbs having a maximum value to 81.111 ohms
- Bridge balance obtained by use of a convenient set of step-by-step switches
- Optional external accessory for 4-lead resistance thermometers and zero correction
- Bridge may be conveniently calibrated by means of an accessory calibrating resistor

8067 TYPE G-I MUELLER TEMPERATURE BRIDGE

A precision instrument designed to measure temperature or temperature differences to a high degree of accuracy with resistance thermometer bulbs.

APPLICATION

For use where the extreme accuracy of the Type G-2 Mueller Bridge is not required. The following are omitted: constant temperature chamber, its accompanying heater and Thermostatic Control Unit; Binding post and rheostat for equalizing resistance thermometer lead-resistances, adjustable battery rheostats, milliameter and galvanometer damping resistor and switch.

SPECIFICATIONS

Measuring Arm.....Range, 0 to 81.111 ohms in step of 0.0001 ohm. Measuring arm consists of: Three shunted decades to give steps of 0.0001, 0.001 and 0.01 ohm, two decades at the ends of the ratio arms of 0.1 and 1 ohm steps, and binding posts on the end of the measuring arm by means of which 0, 10, 20, 25, 25.5, 30, 40, 50, 60 or 70 ohms may be inserted.

Ratio Arms........500 ohms each. Adjustable to equality

Limit of Error....±0.0002 ohm up to one ohm; ±0.02% from one ohm to 81.111 ohms.

Case..............Metal, gray enamel finish with cover.

Weight............Net, about 25 lb (11.34 kg); shipping, about 37 lb (16.78 kg)

ACCESSORIES RECOMMENDED

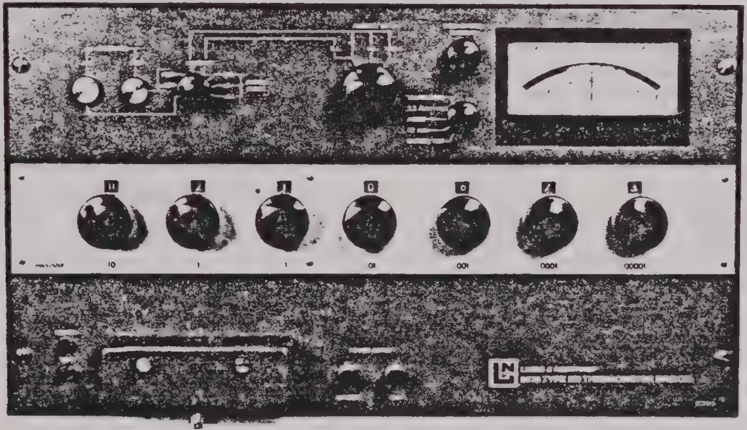
2437-0-☐	D-C Null Detector
056001	No. 6 Dry Cell, 1.5 volts One to four dry cells (or the equivalent in a storage battery) depending upon the type of thermometer being used.
8068	Mercury Commutator for use with four-terminal potential lead thermometer bulbs. Three-pole, double-throw, mercury-contact switch, with plug and blocks for obtaining zero reading. Weight: about 2 lb (0.9 kg); shipping, about 4 lb (1.8 kg)

FORMER MODEL 8067 TYPE G-I MUELLER BRIDGE

TO EXTEND RANGE OF OLDER MODEL 8067 (0 to 51.111 ohms) to 81.111 ohms. If customer already has an older model 8067 Bridge with range of 0 to 51.111 ohms (originally designed for use with 8160 and 8162 Platinum Resistance Thermometers) and wishes to extend the range to 81.111 ohms to permit use and calibration up to the sulfur boiling point (approximately 445 C), a special 30-ohm resistor can be supplied. Similar in appearance to the 4206 Standard Resistor, this special resistor is mounted external to bridge and arranged for connection to the bridge by means of a trip connector. A binding post will be provided for the other connection.

Use of the 30-ohm resistor is as follows: For measurements up to 51.111 ohms, the "C" lead is connected to the binding post on the resistor and the strip connector on the resistor is connected to the terminals C20, C30, or C40 on the bridge for measurements up to 61.111, 71.111 and 81.111 ohms respectively. Limit of error when the external resistor is employed is the same as regularly stated for the bridge alone. For price of special 30-ohm resistor, see Section 1.1-1-2.

8079-B TYPE ER THERMOMETER BRIDGE



FEATURES

- *Seven-dial in-line readout: 0-16111.110 ohms in 4 ranges*
- *Range change accuracy of ±1 ppm*. . . Allows comparison of decade-valued resistors to accuracies approaching ±1 - 2 ppm from 1 ohm to 10,000 ohms*
- *Minimal effects from lead resistance unbalances through use of special bridge arm configurations***
- *Provision for typewriter or tape printer as printout device (wiring for both serial and parallel readout)*
- *L&N Report of Calibration supplied. . .permits even and odd value resistance measurements to an accuracy of ±5 ppm (0.0005%)*
- *Temperature controlled chamber. . .An ambient change of ±5° C from 25° C calibration ambient produces less than 1 ppm shift in the bridge reading*
- *Low self-heating effect*
- *Ten-turn rheostat for fine adjustment of thermometer current and multi-purpose meter on front panel*
- *Can be used as a precision four-terminal resistance box*
- *User easily calibrates using basic build-up technique*
- *Complete electrostatic shielding*

The 8079-B Type ER (Extended Range) combines high accuracy with convenience of operation through use of a multi-patented circuit configuration. While designed primarily for thermometry work, it is equally well-suited for the measurement of two, three, and four-lead resistance devices of either decade or odd values.

The four measurement ranges allow the use of a large variety of resistance thermometers, including the new 0.23 ohm "gold point" thermometers, the classical 25.5 ohm thermometers, and those having an R_o (resistance at 0° C) of 1000 ohms and above. The overall equivalent temperature measurement accuracy for the bridge, when used with an L&N 8163, 8164 or 8167-25 Platinum Resistance Thermometer, is better than 2 millidegrees between −50° and +100° C, increasing to 5 millidegrees at −183° and +630° C, achievable without commutation of leads.

SPECIFIC APPLICATIONS

1. RAPID BRIDGE BALANCE MEASUREMENTS

The reduction of the effect of lead resistance unbalance permits a single bridge balance to obtain an accurate reading, resulting in more rapid measurements.

** Achievable for the top three ranges through incorporation of the Hamon series to parallel (or series-parallel) resistance transfer technique in the ranging circuitry. Accuracy of ±2 ppm applies to the lowest range multiplier which can be readily calibrated from the front panel*

*** Particularly convenient when used with resistance thermometer detectors since commutation is not necessary when the leads are nominally balanced.*

SPECIFIC APPLICATIONS (Cont'd)

2. CONTINUOUS MONITORING OF TEMPERATURE CHANGES

Temperature changes can be monitored continuously by recording the output of the null detector (used with the bridge) on a strip chart recorder. Conditions of ambient temperature change have negligible effect on lead unbalance of the thermometer

3. MEASUREMENTS WITH SEVERAL THERMOMETERS

Thermometer comparison measurements, differential temperature measurements, or other measurements involving more than one thermometer may be made accurately by employing a silver-alloy contact switch (e.g., L&N 8070-C5 Resistance Thermometer Commutator) for the selection of each thermometer.

4. MEASUREMENT OF LOW AND HIGH RESISTANCE

Thermometers having either low-valued or high-valued R_o's may be accurately measured throughout their range due to the extended range of the bridge and the precise range change circuitry.

5. MEASUREMENT OF PRECISE RESISTANCE RATIO AND STANDARD RESISTOR CALIBRATION

The ranging circuitry permits very high accuracy in resistance ratio measurements. For example, a 10,000 ohm standard resistor may be compared with a 1000 ohm, 100 ohm, or 10 ohm standard resistor with an uncertainty of 1 ppm or less and a resolution of 0.1 ppm. Comparison to a 1 ohm standard resistor is accomplished with a resolution of 1 ppm and a comparison uncertainty approaching 1 - 2 ppm. Therefore calibration of decade-valued resistance standards can be made in terms of either a 4210 Thomas Type 1-Ohm Reference Standard or a 4214 10,000-Ohm Reference Standard with an accuracy commensurate with the uncertainty of the reference standard. Calibration measurements are conducted rapidly since only the range multiplier and the lower decade step dials are used. Because the linearity of the first rheostat dial is the only significant source of error, and is known through the L&N Report of Calibration, odd-valued standards can be measured with better than 5 ppm uncertainty.

SPECIFICATIONS

MEASUREMENT RANGES			WARRANTED ACCURACY*	RESOLUTION	RESISTANCE STANDARD CALIBRATION RESOLUTION
MULT.	OHMS	STEPS			
X0.1	0-16.111110	1 x 10^{-6}	±20 ppm of reading or 4 x 10-6 ohms whichever is greater	1 microhm (1.0 millidegree Celsius with 0.23 ohm thermometer)	1 ohm value: 1.0 ppm resolution 10 ohm values: 0.1 ppm resolution
X1	0-161.11110	1 x 10^{-5}	±20 ppm of reading or 4 x 10-5 ohms whichever is greater	10 microhms (0.1 millidegree Celsius with 25.5 ohm thermometer)	100 ohm values: 0.1 ppm resolution
X10	0-1611.1110	1 x 10^{-4}	±20 ppm of reading or 4 x 10-4 ohms whichever is greater	100 microhms	1000 ohm values: 0.1 ppm resolution
X100	0-16111.110	1 x 10-3	±20 ppm of reading or 4 x 10-3 ohms whichever is greater	1000 microhms	10,000 ohm values: 0.1 ppm resolution

*For one year period, without corrections, including range change uncertainty.

Readout......................	Seven dial in-line window readout, direct reading in ohms on the X1 range. Ohms per step for the Rheostat Decades are marked on panel. MULTIPLY BY switch in conjunction with the bridge Function Switch allows selection of multiplier. An option is available to permit paper tape printer or typewriter printout.
Range Change Accuracy.......	±1 ppm or less
Report of Calibration.......	L&N Report of Calibration supplied. Lists corrections in terms of the X1 range which have a calibration uncertainty of ±5 ppm (0.0005%) or 20 x 10-6 ohms, whichever is greater, with reference to the U.S. legal ohm.
Operating Conditions........	Ambient temperature of 20 to 30 C (68 to 86 F), relative humidity of 80% or less.
Circuit.....................	Modified Smith-Gautier bridge circuit consists of a seven decade rheostat and a double set of ratio arms which have resistance values determined from a specific bridge arm relationship. This reduces the effect of thermometer potential lead resistance unbalance by a factor of 1000, 100 and 10 in the X0.1, X1 and X10 ranges respectively. Modified Wheatstone bridge circuit on X100 range.

SPECIFICATIONS (Cont.)

Temp Coefficient of Resistance	Less than 0.2 ppm per degree C (rheostat decades) from 20 to 30 C ambient, referenced to 25°C
Rheostat Decades	Seven switches. The first has fifteen steps of 1000 ohms each. The second through seventh switches have ten steps each of 100, 10, 1, 0.1, 0.01, 0.001 ohms respectively. Panel is marked to be direct reading on the X1 range: 10, 1, 0.1, 0.01, 0.001, 0.0001, 0.00001 (ohms/step) respectively. The sixth and seventh decades are shunted type (Waidner-Wolff) decades
Ratio Arms	Primary Ratio Arms X0.1 Range: One arm consists of an adjustable 100,000 ohm resistance. The adjacent arm consists of ten 1000 ohm resistors connected in parallel to provide a ratio of 1:1000. X1,X10, X100 Ranges: An adjustable 10,000 ohm resistor comprises one arm. The adjacent arm (MULTIPLY BY switch) consists of ten 1000 ohm resistors interconnected upon range selection to provide ratios of 1:100, 1:10, 1:1 on the X1, X10 and X100 ranges respectively Secondary Ratio Arms One arm consists of rheostat decades mechanically ganged with the main rheostat decades in series with a resistor of fixed value dependent on range. The adjacent arm is a range-dependent fixed resistor. Secondary ratio arms are disconnected for the X100 range
Function Switch	Eight positions: CALIBRATE X0.1; CALIBRATE X100, NOR (Normal); CALIBRATE X100, REV (Reverse); MEASURE (X1, X10 and X100 ranges); MEASURE (X0.1 range); BRIDGE CHECK, X10; BRIDGE CHECK, X1; BRIDGE CHECK, X0.1
Multiply By Switch	Three positions: 0.1 & 1; 10; 100
Meter and Meter Function Switch	Taut band meter has three 4-inch scales with 100 graduations each, zero center. Switch has five positions: TEMPERATURE, 2.5 mA, METER, 10 mA, BATTERY TEST. Multi-purpose front panel meter monitors Thermometer Current, indicates Internal Bridge Temperature, acts as an auxiliary meter (50-0-50 uA with function switch in METER position) to replace meter of the accessory external null detector or for extended thermometer current ranges. External terminals and shunt permit extension of thermometer current indication above 10 mA
Thermometer Current	Adjustable by means of a ten-turn rheostat located on the top plate. Continuous monitoring of thermometer current on the panel meter in either of two switch-selected ranges, 0-2.5 mA and 0-10 mA
Temperature Control	An enclosure housing the first four rheostat decades, all ratio arms, and associated resistors is maintained at approximately 34.5 C by an internal full-wave SCR control circuit and a mercury-in-glass thermoregulator. A lamp located on the top plate indicates when the heater for this enclosure is activated.
Internal Temp Indication	The output of a thermistor bridge measuring circuit is displayed on the panel meter when the meter function switch is in the TEMPERATURE position. The meter has a range of 27 to 37 C with 0.1 C graduations and 0.3 C accuracy. The voltage level of the thermistor bridge battery is indicated on the meter when switched to the BATTERY TEST mode. The battery is accessable on the rear terminal plate for replacement
Bridge Self-Heating	Less than 0.02 ppm with 2 mA thermometer current (25 ohm thermometer resistance)
Insulation Resistance	Greater than 0.5 x 10^{11} ohms, circuit to ground at 60% relative humidity or less
Shielding	Complete electrostatic shielding permits use of an electronic null detector. On the front plate, a removable aluminum cover shields the four binding posts to which the thermometer leads are connected
Power Supply Keys	Normal and reverse (momentary contact or lockdown) effectively double bridge sensitivity and/or detect thermals
Binding Posts	Low-thermal, gold-plated copper with Lexan insulation. Four-lead thermometers or resistors use the current and potential terminals conveniently located on both front panel and rear terminal plate marked c, C, T, and t. The remaining twelve rear plate terminals are marked Power Supply: + and -; Detector: 1 and 2; Meter: + and -; A; R; X10; Check; X0.1 & X1; and Ground
Calibration	Similar to Mueller Bridge calibration but at a 100 factor higher resistance level. A resistance box and a 10,000 ohm standard are required in the step-up procedure. The necessary bridge arm relationship for the X0.1, X1 and X10 ranges can be easily checked with a reasonably linear null detector using the function switch BRIDGE CHECK position and the CHECK and range binding posts. The zero resistance correction on each range can be checked using the shorting bar supplied marked with the four-terminal resistance value

SPECIFICATIONS (Cont.)

Line Voltage Requirement....	120 volts, 25 watts, 50/60 Hz. Three-wire line cord with three-to-two prong adapter is included
Case.......................	8079-B Bench Type: Cast Aluminum Case 19-1/4" W x 11" H x 9-1/2" deep (489 x 279 x 241 mm) with legs retracted, 11-3/8" deep (289 mm) with legs extended. Net weight 36 lb (16.3 kg); shipping weight: 40 lb (18.1 kg) 8079-1-B Rack Type: Sheet Metal Case 19" W x 10-15/32" H x 8-1/2" deep (483 x 266 x 216 mm) behind relay rack. Net weight: 25 lb (11.3 kg); shipping weight: 29 lb (13.1 kg)

OPTIONS

-R: External Readout........	Provides maximum flexibility: either a paper tape printer or typewriter can be used as printout device. A 120 pin connector (located on the rear terminal plate) and associated wiring to rheostat decades and range switch provide for either parallel or serial printout or display. Pins normally provide parallel readout but can be converted to serial readout in the field (externally jumpered)

ACCESSORIES

NECESSARY ACCESSORY EQUIPMENT:

9838 D-C Null Detector. Used for measurements up to 100 ohms; required for use with the 8171 "Gold-Point" thermometer.

9828-2 D-C Null Detector. Used for general measurements, preferred for L&N 8160, 8163, 8164 and 8167-25 Thermometers.

With either null detector a temperature sensitivity of better than 1/2 millidegree can be obtained throughout the range of a 25.5 ohm thermometer. The 9838 provides greater sensitivity at the lower resistance levels (less than 10 ohms).

056021 Battery (Burgess 2F2H, 3 Volt Carbon Zinc Type "A" or equivalent).

CALIBRATION EQUIPMENT:

4040-B NBS Type Resistance Standard 10,000 Ohm. For calibration in term of the legal ohm.

4214-B NBS Type Resistance Standard 10,000 Ohm. Preferred for highest accuracy in terms of the legal ohm.

127287 Mercury Cup Stand (2 required)

128436 Copper Link

4757 D-C Resistance Box

056053 Battery (Burgess F4BP 6 Volt Carbon Zinc Type "A" or equivalent)

RESISTANCE THERMOMETER SELECTOR

8070-C5 Commutator, Bench Type

RESISTANCE THERMOMETER COMMUTATOR 8070-C5 (FOR 8079-B BRIDGE)

The 8070-C5 Resistance Thermometer Commutator allows selection of as many as five resistance thermometers for the purpose of thermometer calibration by the comparison method, differential temperature measurements, or discrete temperature measurements.

SPECIFICATIONS

Rotary Selector Switch.......	Twelve positions. One normal (N) and one reverse (R) position for each of five four-lead resistance thermometers (connected at rear terminal panel) permit selection of thermometer or reversal of thermometer leads when desired. Two positions (OPEN) open-circuit bridge connection to permit bridge ratio calibration without removing leads. Switch is L&N Type 01 series, silver alloy, paralleled contacts. Contact resistance variation: Less than 0.0002 ohm (equivalent to less than 0.2 microhm on the lowest range [0-16 ohms], or less than 2 microhms on the X1 range [0-160 ohms] of the 8079-B Type ER Thermometer Bridge)
Internal Potential Lead Resistance Unbalance.........	Less than 0.0002 ohm
Binding Posts................	Twenty-five: five sets marked c, C, T, t for thermometer leads; 1 set marked c, C, T, t for connection to the bridge; 1 ground post
Case.........................	8070-C5 (Bench): 12-9/32" W x 5-1/64" H x 7-53/64" deep + 7/16" for feet (312 x 128 x 199 mm + 11 mm for feet) Net weight: 10 lb (4.5 kg); shipping weight: 12 lb (5.4 kg)

GUARDED NANOVOLT D-C NULL DETECTOR

APPLICATION

Designed for laboratory use with the 7556 Six-Dial Potentiometer, 7555 K-5 Potentiometer, and other instruments requiring resolution to 5 nanovolts (in low resistance circuits - see "Sensitivity" below).

OUTSTANDING FEATURES

- Complete isolation from the power line can be accomplished by powering the detector from an internal rechargeable battery.
- The 60 Hz common mode rejection is 10^8:1 (160 db) when powered from the line.
- Guarded input circuitry is provided for use with guarded instruments.
- Monitoring over extended periods can be accomplished by connecting a recorder to output terminals provided on the detector.

9838 GUARDED NANOVOLT D-C NULL DETECTOR, BENCH TYPE

SPECIFICATIONS

Sensitivity	5 nanovolts per division with 0 to 30 ohms source resistance 10 nanovolts per division with 300 ohms source resistance 30 nanovolts per division with 1000 ohms source resistance
Sensitivity Control	Continuously adjustable with maximum attenuation of 10,000:1, marked with arbitrary scale of 0 to 10
Noise	Less than 10 nanovolts peak-to-peak with 300-ohms source resistance
Input Impedance	300-ohms
Zero Stability	With Time (on line operation and battery fully charged) after 1 hour warm-up: Better than 10 nanovolts per hour noncumulative Better than 30 nanovolts per day noncumulative With Change in Source Resistance: Less than 40 nanovolts for 0 to 300 ohms With ±10% Line Voltage Change: Negligible
Zero Suppression	0 to ±4 microvolts (minimum) continuously adjustable. Has separate on-off toggle switch
60 Hz Rejection	Common mode rejection greater than 160 db. Normal mode rejection greater than 80 db.
Overload	Source voltage should not exceed 0.15 x source resistance
Guarding	Entire input circuit is d-c guarded. 10^9 ohms shunted by 0.003 microfarads between guard and ground
Speed of Response (for 90%)	Less than 2.7 seconds with source resistances up to 100 ohms, less than 3.5 seconds with source resistances to 1000 ohms.
Function Switch	Six positions, 360 degrees rotation with two OFF positions. The selected functions are: BATTERY - The detector is powered by an internal rechargeable battery and is isolated from the line. Line cord supplies only a ground connection. A-C LINE - The detector is powered from the 50-60 Hz line. The internal battery is trickle charging. Amber signal lamp is lighted BATTERY CHARGE - The detector is off. The internal battery is charging at a fast rate. Red signal lamp is lighted. BATTERY TEST - Red line on meter indicates low limit for battery voltage OFF - Two positions provided to turn detector off. The battery is trickle charging and amber light lighted as long as line cord is connected to power line.
Meter	50-0-50 microampere meter movement, taut-band suspension. 4 inch scale with 50 divisions marked 5 to 0 to 5 (1 division = 2 mm). Has red line to indicate battery condition.
Recorder Output	-5 to 0 to +5 millivolts
Power Requirements	3 volt-amperes at 120 volts, 50/60 Hz
Dimensions	Bench Mount 7-1/2"H x 12-3/8"W x 7"D (191 x 314 x 178 mm)
Weight	Net, about 13 lb (6 kg). Shipping, about 16 lb (7.3 kg)
Directions	177468

9838-1 GUARDED NANOVOLT D-C NULL DETECTOR, PANEL-MOUNTED

Same as 9838 except:

Dimensions	7"H x 19"W x 7"D (191 x 483 x 191 mm)
Weight	Net, about 10 lb (4.5 kg). Shipping, about 13 lb (6 kg)

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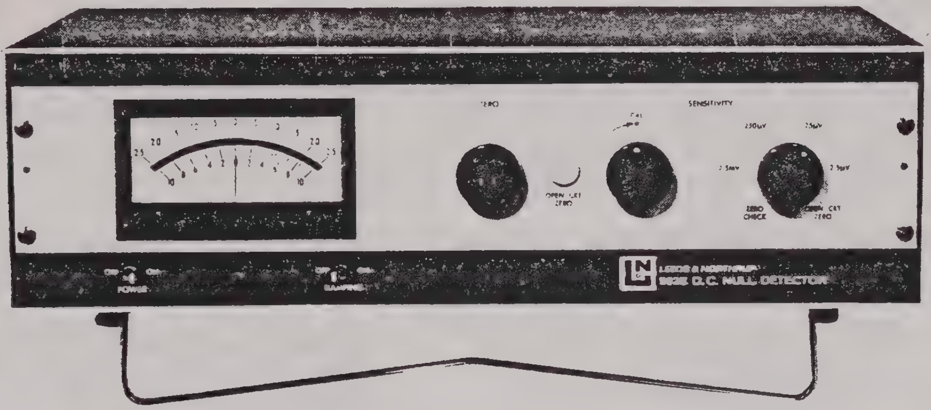


9828 BENCH TYPE, 9828-1 RACK TYPE

The 9828 D-C Null Detector is a fully solid-state a-c guarded instrument designed for use in detector or amplifier applications involving signals down to the 0.1 microvolt level.

In addition to use as a null detector for bridges, potentiometers and ratio sets, the 9828 (1) accurately measures voltage over the range of 0.1 μV to 2.5 mV; (2) acts as a preamplifier for recorders to extend recording ranges to the 0.1 μV signal level; (3) provides calibrated deviation indication or amplification by means of the continuously adjustable sensitivity control; and (4) acts as a fast responding preamplifier for differential control applications.

9828-2 BENCH TYPE, 9828-3 RACK TYPE

The 9828-2 and 9828-3 Null Detectors, modified versions of the 9828 and 9828-1 D-C Null Detectors, are designed to provide higher sensitivity and lower noise with source resistances below 25,000 ohms. Specific applications for the 9828-2 and 9828-3 include use as a deviation indicator or null detector with the 4398-M Double Ratio Set, the 8069 Type G-2 Mueller Bridge, the 8071 Type G-3 Mueller Bridge and the 8079 Type ER Bridge.

For resistance thermometry applications, the null detector has an auxiliary scale marked 15—0—15 that can be calibrated to read temperature deviations directly. When using a platinum resistance thermometer having a nominal Ro of 25.5 ohms, the auxiliary scale can be calibrated to correspond to ±15 millidegrees C full scale, which corresponds to 0.5 millidegree C per scale division. To achieve this sensitivity the thermometer current required is less than 1.6 milliamp for the 8079 ER Bridge, and less than 1.0 milliamp for the Mueller Bridges throughout the entire temperature range of L&N 25.5 ohm thermometers. In general, the highest sensitivity, and hence the lowest current requirement, is achievable at a resistance level near the Ro point of the thermometer.

OUTSTANDING PERFORMANCE CHARACTERISTICS

High normal-mode rejection, exceptional common mode rejection, and isolation between input and line make this instrument ideal for those applications traditionally plagued with interference problems. The extremely low capacitance coupling between input and line provides an instrument that has minimal influence on the input signal — essentially no line frequency voltage can be coupled back through the input leads to the source.

- **200 dB common mode rejection with line operation**
- **Input-to-line isolation equivalent to 10^{10} ohms shunted by 50 picofarads**
- **Noise level of 6 nV RMS typical, with input shorted**
- **Zero stability of 200 nV/24 hrs, noncumulative**
- **Open circuit and short circuit zero adjustments**

OUTSTANDING DESIGN FEATURES

- All silicon solid-state circuitry
- Balanced full-wave FET chopper circuit. Advantages:
  High input impedance
  Excellent zero stability with time
  Low voltage and current offsets
  Low noise
  Decreased sensitivity to power frequency interference
- Calibrated, switch-selected sensitivity settings plus an additional continuous adjustment which provides an attenuation factor of 20:1 for each switch setting
- Fixed and adjustable recorder outputs
- Designed for operation from either 115 volt or 230 volt 48 Hz to 62 Hz line. Provision is also made for external battery operation
- A-C guarded to improve common mode rejection. A-C guard can also serve as d-c guard if required.

SPECIFICATIONS

	9828 and 9828-1			9828-2 and 9828-3		
RANGES	Four, switch selected: ±2.5 µV, ±25 µV, ±250 µV, ±2.5 mV			Four, switch selected: ±1 µV, ±10 µV, ±100 µV, ±1 mV		
MAXIMUM SENSITIVITY	100 nV/div on upper scale			40 nV/div on upper scale		
INPUT IMPEDANCE	Greater than 100,000 ohms on all ranges			Greater than 80,000 ohms on all ranges		
METER NOISE (Note 1)	Less than 15 nV rms or 60 nV peak-to-peak			Less than 10 nV rms or 40 nV peak-to-peak		
INPUT VOLTAGE OFFSET Adjustable to zero	Temperature Coefficient, 10 C to 40 C: Less than 30 nV/°C Range of adjustment, Zero Control: 0 to ±30 µV			Temperature Coefficient, 10 C to 40 C: Less than 30 nV/°C Range of adjustment, Zero Control: 0 to ±10 µV		
EFFECT OF SOURCE RESISTANCE	Source (Ohms)	Sensitivity/Div.* (2.5 µV Range)	Typical Meter Noise (DAMPING switch ON)	Source (Ohms)	Sensitivity/Div.* (1 µV Range)	Typical Meter Noise (DAMPING switch ON)
	0	0.1 µV	6 nV rms	0	40 nV	6 nV rms
	10,000	0.11 µV	10 nV rms	5,000	43 nV	8 nV rms
	50,000	0.15 µV	20 nV rms	10,000	45 nV	10 nV rms
	100,000	0.2 µV	25 nV rms	25,000	53 nV	15 nV rms
	* Sensitivity is at least as great as shown.					
STEP RESPONSE TIME (0–90% of full scale)	Meter and Output: Less than 1 second for source resistance up to 5 KΩ increasing to 4 seconds at 100 KΩ			Meter and Output: Less than 1.5 seconds for source resistance up to 5 KΩ increasing to 4 secs. at 25 KΩ		
MAXIMUM INPUT OVERLOAD	30 volts d-c or rms a-c (Continuous)			20 volts d-c or rms a-c (Continuous)		

Note 1: Meter noise is referred to the input with the input shorted and damping switch ON. Peak-to-peak values are specified at the 2 sigma level (noise less than specified value 95% of the time).

ACCURACY AT 25 C: ± 5 mV Output: ±(1% of range +0.1 microvolt). Meter: ±(3% of range +0.1 microvolt), equivalent to ±(1-1/2% of F.S. +0.1 microvolt). Temperature Coefficient: ±0.25%/°C maximum, 10 C to 40 C.

NOTE: Accuracy statement applies only when SENSITIVITY control is rotated to its extreme clockwise limit, CAL position, and source resistance is less than 300 ohms. Specification for ±5 mV output applies for load resistances of 50 KΩ minimum at balance. Accuracy specifications do not include zero drift and noise.

SENSITIVITY CONTROL: Continuously adjustable – up to 20:1 attenuation on any range. Range calibration applies when control is rotated clockwise to its CAL position.

INPUT CURRENT OFFSET: Adjustable to zero. Temperature Coefficient: Less than 6 pA/°C, 10 C to 40 C. Range of Adjustment: OPEN CKT ZERO Control: 0 to ±100 pA.

ZERO STABILITY: With Time: Less than 0.1 microvolt per hour, noncumulative, less than 0.2 µV/24 h, noncumulative. With Temperature: Sum of effects of voltage and current offset coefficients – less than 30 nV/°C +6 pA/°C x (R_s + R_f), where R_s is the source resistance and R_f is the resistance in the input filter. R_f = 10 K Ω for the 9828 and 9828-1, R_f = 6 K Ω for the 9828-2 and 9828-3. With ±15% Line Voltage Change: Negligible.

OUTPUT DAMPING: Damping switch increases step response time by more than 1.5 seconds for any source resistance.

OUTPUT: Calibrated, ±5 mV: 5–0–5 mV corresponding to full scale meter deflection. Output resistance is 100 ohms. Adjustable, ±(5 to 50) mV: 5.1–0–5.1 millivolts to 50–0–50 millivolts corresponding to full scale meter deflection. Output resistance is 102 ohms at low end of adjustment range, increasing to 1000 ohms at high end.

INTERFERENCE REJECTION: D-C Common Mode Rejection: Guard and common mode source connected to input +. Input shorted – greater than 200 dB. 1000 ohms source resistance – greater than 150 dB.

50–60 Hz Common Mode Rejection: Guard and common mode source connected to input +. Input shorted – greater than 200 dB (p-p/d-c) or 191 dB (rms/d-c). 1000 ohms source resistance – greater than 180 dB (p-p/d-c) or 171 dB (rms/d-c).

50–60 Hz Normal Mode Rejection: Greater than 90 dB (p-p/d-c) or 81 dB (rms/d-c) on all ranges for normal mode voltages up to 1000 times full scale but not exceeding 1 V rms.

OVERLOAD RECOVERY TIME: Less than 3 seconds to

SPECIFICATIONS (Cont.)

recover to within 3 divisions of balance for a 1000-times full-scale overload on all ranges.

MAXIMUM INPUT VOLTAGE ABOVE GROUND: 500 volts d-c or rms a-c.

INPUT TO LINE ISOLATION: 10^{10} ohms shunted by 50 pF. (Three-terminal resistance and capacitance measurements using the guard as the third terminal.)

GUARDING: 10^9 ohms shunted by 2 nF between guard and ground.

ENVIRONMENTAL LIMITS: Operating: 10 C to 40 C (50 F to 104 F), up to 80% relative humidity. Storage: -20 C to +65 C (-4 F to +149 F), up to 95% RH.

POWER REQUIREMENTS: Line Operation: 115/230 volts ±15%, 48/62 Hz, 2 VA. External Battery Operation: 16 to 24 volts d-c, 28 mA maximum.

PHYSICAL DATA	9828 and 9828-2	9828-1 and 9828-3
Mounting	Bench	Relay Rack
Case	Extruded aluminum, Gray	Sheet metal, Gray
Dimensions	6-5/32″ H x 19-11/32″ W x 9-9/16″ D (156 mm x 491 mm x 243 mm)	5-7/32″ H x 19″ W x 9-7/32″ D (133 mm x 483 mm x 234 mm)
Weight	18 lb (8.2 kg)	12 lb (5.4 kg)

OPTIONS

-A Suffix: Adjustable active output, ±(0 to 1 volt). With this feature, the instrument can supply 1 milliamp into a 1000 ohm load. Output impedance is less than 1 ohm. This option replaces the standard 5.5 mV to 55 mV adjustable output.

ACCESSORIES FOR 9828 SERIES

836012 (22-36-11)★ Input Cable Leadwire

324093 Mounting Kit (Bench Model). Used to mount detector on bench mounted measuring instruments using 239063 cast aluminum case

324239 Active Output Kit. Converts existing 9828 Series instruments to -A option.

056065 Battery (for use if battery operation is desired) Life: 55 days at 4 hrs/day

★*Specify length required in feet.*

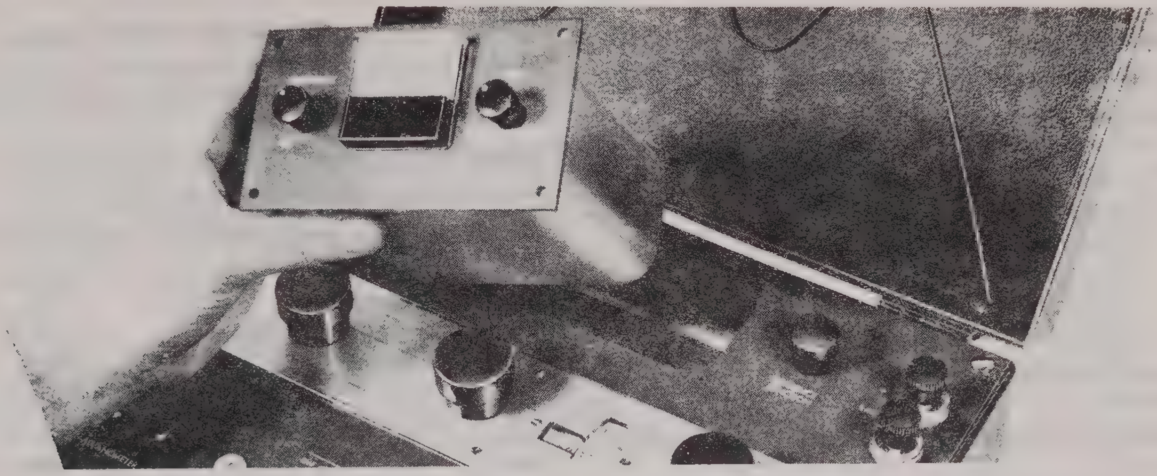
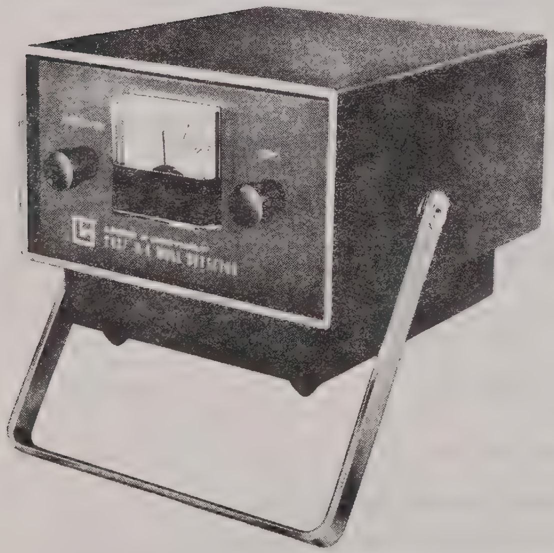


Photo EE-1394

2437-2-☐ COMPONENT TYPE DETECTOR
Can be used with L&N portable instruments, or with user's test equipment.



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2437-0-20 BENCH TYPE DETECTOR
Shown equipped with Mercury-battery power supply.

062437-☐-☐☐ D-C NULL DETECTOR (HIGH IMPEDANCE) (For suffix designations, see next page)

A compact line or self-contained battery-operated, advanced solid-state circuit, easy-to-read, null detector available in a variety of mountings. May be used with any instrument that requires up to 0.5 uV sensitivity ... i.e., Wheatstone bridge, Kelvin bridge, potentiometer.

FEATURES

- Completely solid-state circuit
- Balanced MOS-FET (Metal Oxide Silicon-Field Effect Transistor) input chopper having the following advantages:
  - High input impedance
  - Excellent zero stability with time and with changes in source resistance
  - Low noise
- Insensitivity to mounting position
- Zero stability with changes in sensitivity control
- Wide range of mounting and power supply options

SPECIFICATIONS

Sensitivity Better than 0.5 uV per div. with source resistances up to 5 K; 1.0 uV per div. from 5 K to 50 K.

Sensitivity Control Greater than 100:1 attenuation, continuous adjust.

Noise Less than 0.5 uV peak-to-peak with 50 K source resistance.

Input Resistance 50,000 ohms.

Zero Stability Less than 1.0 uV per hour after warm-up.

Zero Shift Less than 0.5 uV with 0 to 10 K source resistance.

Zero Control 0 to ±20 uV, continuous adjust.

2437-☐-☐☐ D-C NULL DETECTOR (HIGH IMPEDANCE)

Zero Control 0 to ±20 uV, continuous adjust.

60 Hz Rejection Either line or battery-operated, common mode rejection greater than 140 db (10^7:1); differential mode rejection greater than 90 db (30,000:1).

Response Time

Source Resis.	Time (0 to 90%)
0 to 1 K	1.2 Sec.
0 to 10 K	4.1 Sec.
0 to 50 K	5.2 Sec.

Input Overload 20 volts d-c or 20 volts rms a-c max. w/o damage.

Overload Recovery With 1 K source resistance as follows:

Overload	On Scale (within 5 uV)	Recovery To Within 1 Div. (0.5 uV)
10 x Full Scale (50 uV)	1.0 Sec.	1.8 Sec.
100 x Full Scale (500 uV)	1.5 Sec.	2.7 Sec.

Insulation Greater than 10^9 ohms input to case.

Meter 50–0–50 microamp movement, taut band suspension, 1.3 inch scale with 20 div. marked 10, 5, 0, 5, 10 (1 div. = 1.6 mm)

Power Requirements 3.5 mA at 12 to 13 volts, d-c.

Power Supply *As specified by 2nd suffix.*

Model Type *Bench, Panel or Component type as specified by 1st suffix.*

Dims. and Weights

	-0-☐ Bench Type	-1-☐ Panel Type	-2-☐ Comp. Type
Height	4″ (102 mm)	4-3/4″ (121 mm)	3″ (76 mm)
Width	6″ (152 mm)	6″ (152 mm)	5-1/2″ (140 mm)
Depth	8″ (203 mm)	8″ (203 mm)	5-1/2″ (140 mm)
Weight	3-1/2 lb (1.6 kg)	2 lb (0.91 kg)	1-1/2 lb (0.68 kg)

Dims. and weights exclusive of power supplies.

Drawings Outline and dims. drawings: 2437-0-☐☐ (A-DIM-2219-33); 2437-1-☐☐ (A-DIM-2219-30); 2437-2-00 (A-DIM-2219-30-13).

SUFFIX DESIGNATIONS

Model (1st Suffix)	Six-Digit (Part No.)	Cat. No.	12 Volt D-C Power Supply (2nd Suffix Specifies)		
			Type	Description	Part No.
Bench Type *(Note 1)*	742753	2437-0-00	(none)	——	——
	742841	-10	Battery (2000 hr)	Two 6-volt batteries (external)	(2) 056053
	742842	-20	Battery (265 hr)	Kit: two mercury batteries and holder	099098
	742845	-40	Power Supply	Line-powered 120 V, 50-60 Hz	099083
Component Type *(Note 2)*	743098	2437-2-00	(none)	——	——
	742850	-10	Battery★★	Two 6 V batteries	(2) 056053

★★ External components of detector assembly, designed for mounting inside portable instruments. *(Note 2).*

1. Bench type, rugged extruded aluminum case. Carrying handle can be positioned as a stand to tilt instrument for convenient operation at any angle. Binding posts at rear. Power supply options except −10 are attached to underside of detector.
2. Component type. The 2437-2-10 is used in L&N's large case portable, e.g., 4287-2, 4289-2, 8064-2 Bridges, 8686-2, 8687-2 Potentiometers. The 2437-2-☐ includes Kit 124844 containing miscellaneous resistors and directions for installation of the electronic null detector in L&N reflecting galvanometer type instruments, i.e., the former portables without the "−2" suffix. Integrally mounted galvanometer lamp batteries must also be removed (insufficient voltage), but are electrically and physically replaced by the detector's power supply when the listed suffixes are specified. *NOTE:* Measuring circuit batteries are not affected.

324050 SOLID-STATE NULL DETECTOR KIT TO REPLACE POINTER GALVANOMETER

The 324050 Kit of Parts includes the necessary components to replace the pointer galvanometer in 8690, 8691, 8692 and 8693 Portable Potentiometers, with a battery operated, solid-state null detector. Advantages of the null detector over the galvanometer are increased sensitivity, higher input resistance and the capability of operating in any plane.

The kit consists basically of two pre-wired assemblies; a molded compartment containing a meter, on-off switch and zero potentiometer, and a bracket containing a printed circuit assembly and batteries. The assemblies are designed to mount over the existing galvanometer opening on the above mentioned potentiometers. Installation requires drilling of two noncritical holes in top plates.

SPECIFICATIONS

Sensitivity	50 microvolts per meter division
Noise	Less than 10 microvolts peak-to-peak
Input Resistance	10,000 ohms
Zero Stability	With time: less than 10 microvolts per hour, noncumulative With temperature: less than 10 microvolts per degree C With source resistance: less than 10 microvolts for a 1000 ohm change
Zero Adjustment Range	±15 millivolts
60 Hz Rejection	Common Mode: 140 dB Normal Mode: 70 dB
Response Time	1.5 seconds
Overload Recovery	On scale within 1 second for 100 x full scale overload at 1000 ohms source resistance
Power Supply	Two self-contained mercury batteries ±4.05 volts @ 1 mA
Battery Life	Approximately 1000 hours of operation
Meter	50-0-50 microampere meter movement, taut band suspension. One and one-half inch scale with 20 divisions marked 10 to 0 to 10 (1 division = 2 mm). Meets requirements of ANSI C39.1
Directions	177641

MAXIMUM EXTERNAL RESISTANCES FOR POTENTIOMETERS

The increased sensitivity and higher input resistance of the null detector permit the potentiometer to be used with higher values of external resistance.

CATALOG NO.	MAXIMUM EXTERNAL RESISTANCE WITH NULL DETECTOR	MAXIMUM EXTERNAL RESISTANCE WITH GALVANOMETER	
8690	1000 ohms	50 ohms approx	(062112 supplied)
8691	High Range: 200 K Low Range: 10 K	High Range: 0 to 2000 ohms Low Range: 0 to 200 ohms	(062112 supplied with potentiometer)
		High Range: 500 to 4000 ohms Low Range: 10 to 300 ohms	(062113 separately purchased)
		High Range: 3 K to 10 K ohms Low Range: 200 to 800 ohms	(062114 separately purchased)
8692	10 K ohms for standard ranges 1 K ohms for 5 mV special ranges	50 ohms approx	(062111 supplied)
8693	Same as 8692	Same as 8692	(062111 supplied)

REPLACEMENT PARTS — SEE DIRECTIONS 177641

324190 D-C NULL DETECTOR KIT

Designed to replace the light beam galvanometer supplied with the following instruments:

4287	Kelvin Bridge	8064-A	Resistance Thermometer Bridge
4289	Wheatstone Bridge	8686	Millivolt Potentiometer
8064	Resistance Thermometer Bridge	8687	Volt Potentiometer

FEATURES

- Higher sensitivity, higher input impedance and faster response than the light beam galvanometers
- Not affected by operating position
- More rugged than the galvanometers - not as susceptible to shock and vibration
- Input is overload protected up to 35 volts
- High common mode rejection - 100 volts of common mode voltage affects the meter reading by less than 1 μV with a source resistance of 1000 ohms

SPECIFICATIONS

Sensitivity	5 microvolts per meter division (each division = 1.5 mm)
Input Resistance	5600 ohms
Noise	Less than 3 microvolts peak-to-peak
Zero Adjustment Range	Voltage Offset: ±350 microvolts Current Offset: ±150 nanoamperes
Temperature Coefficient of Zero Offset	Voltage Offset: ±5 microvolts per degree C maximum Current Offset: ±300 picoamperes per degree C maximum
Response Time	Less than 1 second, 0 to 90% of deflection
Interference Rejection	DC Common Mode Rejection: 140 db with 1000 ohm source resistance 50/60 Hz Common Mode Rejection: 160 db with 1000 ohm source resistance 50/60 Hz Normal Mode Rejection: 60 db
Overload Recovery Time	On scale within 1 second for 100 full scale overload with 1000 ohm source resistance
Maximum Input Overload	Input protected against continuous overloads up to 35 volts
Power Requirements	±3 volts at 2 milliamperes Battery life: 2000 hours operation or 10 months whichever is less
Meter	50-0-50 microamperes, taut-band suspension 2-1/2 inch scale with 40 divisions marked 10-0-10, each division = 1.5 mm
Shipping Weight	5 lb, (2.3 kg)
Directions	177598

REPLACEMENT PARTS FOR 324190, SEE DIRECTIONS 177598

PARTS SUPPLIED WITH 324190 KIT

1	324184	DC Null Detector	1	311729	Resistor, 560 K
1	337250	Cable	5	089037	Cable Wrap
1	056021	Battery (3 V "Little Six")	1	177598	Directions
			1	B-SD-610	Mtg Drawing

FUNCTION
RANGE
90µV
10µV
LEEDS & NORTHRUP
9829 LINEAR AMPLIFIER

9829 LINEAR AMPLIFIERS Highly accurate, highly stable, fully solid-state, and ac guarded. Available in two models: The 9829 Linear Amplifier, bench or panel mounted. Each can be used as a high impedance preamplifier. Where high interference rejection is mandatory, the 9829 Series offers exceptional common mode rejection. For applications where line frequency voltage must be prevented from being coupled back to the source, this series provides excellent isolation from line.

9829 LINEAR AMPLIFIER Responds to dc signal levels from 100 volts down to 0.1 microvolt. Performs as a calibrated deviation indicator for bridges, potentiometers and ratio sets, or as a preamplifier or isolating amplifier for digital voltmeters or recorders. Provides amplification or deviation indications from low output primary elements such as thermocouples, thermopiles, and strain gage or bolometer bridges. Bench type 9829. Panel mounted version 9829-1.

OUTSTANDING PERFORMANCE CHARACTERISTICS

- Amplifier linearity better than ±0.05% of range
- Input impedance of 10 megohms to 100 megohms
- Ranges up to 100 volts
- Active output, less than 1 ohm output impedance
- Input-to-line isolation equivalent to 10^{10} ohms shunted by 50 picofarads
- 200 dB common mode rejection with line operation
- Zero stability of 200 nanovolts per 24 hours, noncumulative

OUTSTANDING PERFORMANCE CHARACTERISTICS

- All silicon solid-state circuitry
- Balanced full-wave FET chopper . . .
  High input impedance
  Excellent zero stability with time
  Low voltage and current offsets
  Low noise
  Decreased sensitivity to power line interference
- AC guarded to improve common mode rejection. AC guard can also serve as a dc guard if required
- Active output provides 1 volt across a 1000 ohm load with an output impedance less than 1 ohm full scale inputs

SPECIFICATIONS

Note: All specifications apply for temperatures of 25 C ±5 C and relative humidity up to 70% unless otherwise noted.

	9829 and 9829-1 (Bench and Panel Mounted)
RANGES	Sixteen, switch-selected from ±3 μV to ±100 V; 3 and 10 sequence: ±10 μV, ±100 μV, ±1 mV, ±10 mV, ±100 mV, ±1 V, ±10 V, ±100 V multipliers of x1 and x.3 on each range.
VISUAL DISPLAY AND READING RATE	Two scales. Upper scale: 100 divisions marked 1–0–1 Lower scale: 60 divisions marked .3–0–.3
ANALOG OUTPUT	Calibrated: 5–0–5 mV corresponding to full scale meter deflection. Output impedance is 100 Ω Adjustable: Active output adjustable from 0 to 1 V for full scale output and can supply up to 1 V across a 1 kΩ load. Output impedance is less than 1 Ω
BUFFERED DIGITAL OUTPUT	—
OUTPUT LINEARITY	±5 mV: ±0.05% of range ±(0–1 V): ±0.1% of range at 1 V output Zero based
STEP RESPONSE TIME	Meter, for 0 to 90% of Full Scale: Less than 0.75 second for source resistances up to 10 kΩ increasing to 2 seconds at 100 kΩ Output, for 0 to 99.9% of Full Scale: Less than 1.5 seconds for source resistances up to 10 kΩ increasing to 6 seconds at 100 kΩ
3 dB BANDWIDTH	Meter: Greater than 0.49 Hz for source resistances up to 10 kΩ decreasing to 0.18 Hz at 100 kΩ Output: Greater than 0.73 Hz for source resistances up to 10 kΩ decreasing to 0.18 Hz at 100 kΩ
OUTPUT DAMPING	Increases meter step response time by about 0.25 second. Increases output step response time by about 3 seconds for source resistances up to 10 kΩ or about 1 second at 100 kΩ
OVERLOAD RECOVERY TIME	Meter: Less than 1 second to recover to within 1% of balance for 1000 times overload Output: Less than 5 seconds to recover to within 0.1% of balance for 1000 times overload
MAXIMUM SENSITIVITY	100 nV/division on lower meter scale
NOISE	Meter, less than 50 nV rms referred to the input with the input shorted and the Damping switch Off (less than 0.2 μV peak-to-peak at the 2 sigma level; equivalent to less than 0.2 μV peak-to-peak 95% of the time).
POWER REQUIREMENTS	Line operation: 115/230 volts ±15%, 48–62 Hz, 3 VA External battery operation: ±(16–24) volts dc, 28 mA max.

SPECIFICATIONS

ZERO STABILITY	With Time: Less than 0.1 µV/h, noncumulative; less than 0.2 µV/24 h noncumulative. With Temperature: Sum of input voltage and current offset coefficients — less than 30 nV/°C + 6 pA/°C x (25 kΩ + R_S), where R_s is the source resistance and 25 kΩ is the resistance in the input filter. With Change in Source Resistance: Resulting from input current offset — less than 5 pA x ΔR_s when properly adjusted. With ±15% Line Voltage Change: Negligible.
INTERFERENCE REJECTION	D-C Common Mode Rejection, guard and common mode source connected to input ⌿: Input Shorted — greater than 200 dB; 1000Ω source resistance — greater than 160 dB. 50/60 Hz Common Mode Rejection, guard and common mode source connected to input ⌿ : Input Shorted — greater than 200 dB (p-p/d-c) or 191 dB (rms/d-c); 1000Ω source resistance — greater than 180 dB (p-p/d-c) or 171 dB (rms/d-c). 50/60 Hz Normal Mode Rejection: Greater than 90 dB (p-p/d-c) or 81 dB (rms/d-c).
GUARDING	10^9 ohms shunted by 0.002 µF between guard and ground. (Guard is an active [driven] a-c guard shield.)
ENVIRONMENTAL LIMITS	Operating: 10 C to 40 C (50 F to 104 F) up to 80% RH Storage: -20 C to +65 C (-4 F to 149 F) up to 95% RH

ACCURACY, INPUT SPECIFICATIONS

RANGE	ACCURACY *		INPUT IMPEDANCE (at balance)	MAXIMUM CONTIN. INPUT OVERLOAD
	As a direct reading indicator (meter) 9829, 9829-1	As an amplifier, 5 mV output All 9829 Series		
100 V to 100 mV (30 mV▲)	±(2% of range +0.1 mV), equivalent to ±(1% of F.S. + 0.1 mV)	±(0.08% of reading + 0.05% of range + 0.1 mV)	10 megohms	500 V d-c or rms a-c
10 mV to 1 mV (300 µV▲)	±(2% of range +0.1 µV), equivalent to ±(1% of F.S. +0.1 µV)	±(0.05% of reading +0.05% of range +0.1 µV)	≥100 megohms	150 V d-c or rms a-c
100 µV (30 µV▲)			≥50 megohms	
10 µV (3 µV▲)		±(0.3% of reading +0.1 µV)	≥10 megohms	

MAXIMUM INPUT VOLTAGE ABOVE GROUND: 500 V d-c or rms a-c

INPUT TO LINE ISOLATION: 10^{10} Ω shunted by 50 pF (three terminal resistance and capacitance measurements using the guard as the third terminal)

INPUT VOLTAGE OFFSET: Adjustable to zero. Temperature coefficient: Less than 30 nV/° C, 10 C to 40 C. Range of adjustment, Zero Control: 0 to ±80 µV

INPUT CURRENT OFFSET: Adjustable to zero. Temperature coefficient: Less than 6 pA/° C, 10 C to 40 C. Range of adjustment, Open Ckt Zero Control: 0 to ±100 pA

PHYSICAL DATA

	9829	9829-1
Mounting	Bench	Relay Rack
Case	Extruded aluminum, Gray	Sheet Metal, Gray
Dimensions	6-5/32" H x 19-11/32" W x 9-9/16" D (156 mm x 490 mm x 243 mm)	5-7/32" H x 19" W x 9-7/32" D (133 mm x 483 mm x 234 mm)
Weight	19 lb (8.6 kg)	13 lb (5.9 kg)

* *Accuracy specifications do not include zero drift and noise.*
Temperature Coefficient, 9829, 9829-1: Between -0.02%/° C and -0.03%/° C, 10°C to 40°C.
▲ *Lower range value with "X.3" multiplier for 9829, 9829-1 with meter.*

REPLACEMENT PARTS—See Directions 177599

ACCESSORIES

836012 (22-36-11)★	Input Cable Leadwire for 9829 Series
324093	Mounting Kit (Bench type only) Used to mount Linear Amplifier on bench mount measuring instrument using the 239063 cast aluminum case
056065	External Battery (Eveready 762-S or equivalent). For 9829 and 9829-1 only Battery life...27 days at four hours per day.

★ Order desired length in feet.

WITHDRAWN CATALOG INSTRUMENT–________________________–REFERENCE INFORMATION ONLY–

2435-☐ REFLECTING GALVANOMETER WITH ENCLOSED LAMP AND SCALE

Combines a rugged internal-magnet galvanometer system and a lamp scale reading device in one compact, impact-resistant plastic case.

APPLICATION

For most application, can be used with circuits having external critical damping resistances (CDRX) which differ considerably from the values below. May be used with the 8063 Resistance Thermometer Bridge, the 7645 Student's Potentiometer, and many others.

FEATURES

- Optional viewing...horizontal scale on top plate, vertical scale on front of case.
- Rectangular light-band split by a sharply-defined hair line.
- Flexibility of operation...interchangeable systems easily installed for characteristic versatility.

SPECIFICATIONS (Complete specs per table below)

Sensitivity[1] ________/mm

Period ________ sec.

CDRX ________ ohms, external critical damping resis.

System Resis.[2] ________ ohms

Scale 50 one-millimeter div., 25 on each side of a central zero. Markings on back surface of glass to eliminate parallax.

Zero Adjust Two knobs on top of case provide coarse and fine adjust.

Light Source #50 G.E. Lamp operated from 60 or 50 cps voltage by built-in 120 to 6.3 volts transformer. 7-foot power cord with plug provided. Spare lamp mounted on lamp housing. Red indicator provided on vertical front panel to show when galv. lamp is "on" or "off".

Burden 2 watts

Case Molded, impact-resistant plastic. Overall size 3-27/32" wide, 5-1/4" high, 7-9/32" long (98 x 133 x 185 mm)

Weight Net, about 3 lb (1.4 kg); shipping, about 4 lb (1.8 kg)

Order[4] By 6-Digit Part No.	Cat. No. For Ref. Only	Sensitivity[1] mm	Period (Sec.)	Resis. (Ohms)		Repl. Sys.[3]
				CDRX	System[2]	
741671	2435-a	0.1 uA	4.0	35	35	062101
741672	2435-b	0.06 uA	3.0	100	40	062102
741673	2435-c	0.025 uA	3.0	1000	90	062103
741674	2435-d	0.010 uA	3.5	10,000	500	062104

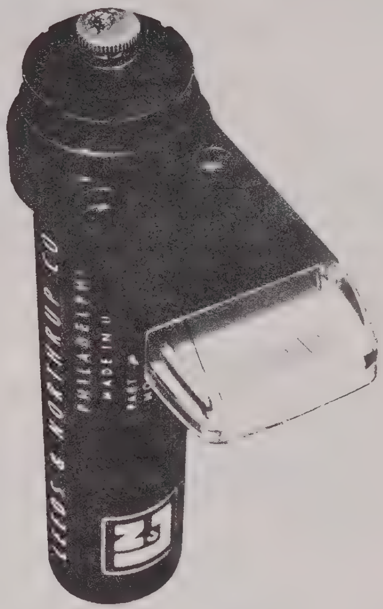
[1] Sensitivity is at least as high as value listed. Other electrical characteristics within ±20%.

[2] System resistance is the resistance of the galvanometer coil plus the resistance of the galvanometer suspensions.

[3] Replacement internal-magnet galvanometer-system only with mirror on coil. *Does not* include optical or light image components.

[4] Prices are in Sect. 1.1-2-2.

06211☐ POINTER TYPE GALVANOMETER



FEATURES

- Completely self-contained
- Wide latitudes of CDRX values – short period.
- Oil damped to minimize vibrations.
- Wrap-around clear plastic window – wide range of viewing angles.
- Interchangeable – top plate screws complete circuit between system and binding posts.
- Coil clamp for periods of non-use.

SPECIFICATIONS Complete specs per table

Sensitivity[1] ________ microampere/mm

Period[1] ________ sec.

System Resis.[1] ________ ohms. Includes resis. of galv. coil and suspensions.

CDRX[1] ________ ohms external critical damping resis.

Scale 20 1-mm divs., 10 on each side of a central zero.

Dims. Barrel length, approx. 4" (102 mm); molded head, approx. 3" x 1-1/4" x 3/4" high (76 x 32 x 19 mm).

[1] *Nominal values are listed for characteristics; sensitivity at least as high as value stated, all other characteristics are within* ±20%.

Part No. Prices, Sect. 1.1-2-2	Sensitivity (Microampere/ Millimeter)	Period (Sec.)	Resis. (Ohms)	
			System	CDRX
062111	1.0	4.0	35	35
062112	0.6	3.5	40	100
062113	0.25	3.5	90	1000
062114	0.1	4.0	500	10,000

ACCESSORIES RECOMMENDED FOR 06211☐

016663	Terminal. Two required.
027180	Retainer Plate. Two required.

2340-☐ INTERNAL MAGNET D-C POINTER GALVANOMETER

A general purpose d-c pointer type galvanometer for use where a rugged and sensitive detector is required.

APPLICATION

For most applications, may be used with circuits having external critical damping resistances (CDRX) which differ considerably from the table values listed below. It must be used with scale in horizontal position. May be used with 7645 Student's Potentiometer, 4340 Students' Kelvin Bridge, 4760 Wheatstone Bridge, 4395 Voltage Divider and many others.

FEATURES

- Self-contained, compact unit.
- Characteristics change – Interchangeable systems easily installed.
- Impact-resistant plastic case.
- Clear, wrap-around, plastic window – wide range of viewing angles.

SPECIFICATIONS Complete specs per table

Sensitivity[1]________ /mm

Period________sec.

CDRX[2] ________ohms, external critical damping resis.

System Resistance[2] ________ ohms

Scale 20 one-millimeter div., 10 on each side of a central zero.

Case Molded, impact-resistant, plastic. Overall size: 2-3/4″ wide, 5-3/16″ high, 5-3/8″ long (70 x 132 x 137 mm)

Weight Net, about 1 lb (0.45 kg); shipping, about 2 lb (0.9 kg)

REPLACEMENT PARTS

062☐☐☐	Complete System (see table)
016697	Binding Post
--	Mounting Screws for Galv.; 5/8″, 4-40 Fil. HB, NP

Order[3] By 6-Digit Part No.	Cat. No. For Ref. Only	Sensitivity[1] mm	Period (Sec.)	Resis. (Ohms)		Repl. Sys.
				CDRX	System[2]	
741667	2340-a	1.0 uA	4.0	35	35	062111
741668	2340-b	0.6 uA	3.5	100	40	062112
741669	2340-c	0.25 uA	3.5	1000	90	062113
741670	2340-d	0.1 uA	4.0	10,000	500	062114

[1] Sensitivity is at least as high as value listed. Other electrical characteristics within ±20%.

[2] System resistance is the resistance of the galvanometer coil plus the resistance of the galvanometer suspensions.

[3] Prices are in Sect. 1.1-2-2.

2324-☐ GALVANOMETER SYSTEM AND MAGNET FOR CUSTOMER MOUNTING

SPECIFICATIONS Complete spec per table

Consists of – Galv. system., PI-24-☐, magnet, and complete set of parts incl. Drawings SD-3-B for mounting on metal panels. 1/16″ to 1/4″ thick and SD-3-A for mounting panels, 3/16″ to 1/2″ thick.

Sensitivity[1]________Microampere/mm

Period________ sec.

CDRX ________ohms, external critical damping resis.

System Resis.________ohms

Order By 6-Digit Part No.	Cat. No. For Ref. Only	System★	Sensitivity (Microampere/ Millimeter)	Period (Sec.)	Resis. (Ohms)	
					CDRX	System
745133	2324-b	354050	4	3	50	20
745134	2324-c	354051	1	3	950	250
745135	2324-d	354052	0.5	3	2400	1000
Discontinued	2324-e	354053	0.8	3-4	500	55

★ Prices are in Sect. 1.1-2-2

PARTS FOR WITHDRAWN GALVANOMETERS

2314-☐ Galvanometer Kit Replacement For PI-50-☐

Order[1] By 6-Digit Part No.	Cat. No. (Reference Only)	Galvanometer System
745216	2314-a	062111
745217	2314-b	062112
745218	2314-c	062113
745219	2314-d	062114
Discontinued	2314-e	062111

THE ABOVE KITS ALSO INCLUDE:

062041 Galv. Adapter, 177423 Directions, B-SD-520-1 Mounting Dwg., (2) Screws; 5/8 x 4-40, and (2) 1 x 10-32.

[1] Prices are in Sect. 1.1-2-2.

NOTE: Space required above the panel for the 2314-☐ is 1/8″ greater than that for the PI-50. Consequently, on portable instruments, it may be necessary to modify the lid to allow complete closure.

SPECIFICATIONS Complete per table

Sensitivity ______ /mm

Period ______ sec.

CDRX ______ ohms, external critical damping resis.

System Resis. ______ ohms

REPLACEMENT GALVANOMETER SYSTEMS FOR WITHDRAWN GALVANOMETERS

Present System No.	Sensitivity (Microamps)	Period (sec.)	Resis. (ohms)		Withdrawn Galvanometer
			CDRX	System	
PI-24-a★	5.0	3	50	20	2320-a, 2322-a
354050 (PI-24-b)	4.0	3	50	20	2320-b, 2322-b
354051 (PI-24-c)	1.0	3	950	250	2320-c, 2322-c
354052 (PI-24-d)	0.5	3	2400	1000	2320-d, 2322-d
354053 (PI-24-e)	0.8	3-4	500	55	2325-e
354020 (PI-102-b)	25	3	80	26	2400-b, 2420-b, 2449-b
2314-a or 062111	1.0	4.0	35	35	PI-50-a, 2310-a ●
2314-b or 062112	0.6	3.5	100	40	PI-50-b, 2310-b ●
2314-c or 062113	0.25	3.5	1000	90	PI-50-c, 2310-c ●
2314-d or 062114	0.1	4.0	10,000	500	PI-50-d, 2310-d ●
2314-e or 062111	1.0	4.0	35	35	PI-50-e, 2310-e ●

● 2310-☐ and PI-50-☐; complete replacement system is 2314-☐.

★ Withdrawn from sale.

REPLACEMENT BATTERIES

For batteries required for specific instruments, see Section 10.8-9-3.

056001	1.5	Volt No. 6 Dry Cell With Spring Clips, Eveready-Columbia
056004	1.5	Volt "Little Six" Ignition Type, Burgess No. 4FH
056007	4.5	Volt "C", Burgess Battery Co. No. 2370
056008	7.5	Volt Burgess No. 5540
056009	22.5	Volt Burgess No. 4156
056011	45.0	Volt Eveready No. 482
056012	1.5	Volt Type D, Eveready No. 950
056013	1.5	Volt Nominal No. 250 Dry Instrument Carboncell. Maximum continuous load, 200 mA.
056017	1.35	Mallory Mercury Cell, Type RM42R
056019	4.5	Volt, Eveready No. 751
056021	3.0	Volt, Burgess 2F2H
056025	1.5	Volt Alkaline Type Dry Cell (ASA "D"), Eveready E95
056026	1.35	Volt ±0.02%, Mallory Mercury Cell Type PX-1-T2
056029	1.5	Volt Dry Cell, No. 915-AA Eveready
056040	12.0	Volt Nickel Cadmium, Gould No. 120
056050	1.35	Volt, Burgess Battery Co.; Mercury Type #HG625R
056051	12.5	Volt, Eveready Y-5403, Nickel-Cadmium. Rechargeable; ten (10) BH500 Cells in series, with solder tabs on each end.
056052	6.75	Volt, Mercury, Burgess H135R, Eveready E135 N, or Mallory TR135R.
056053	6.0	Volt, Burgess No. F4BP, Marathon 496-S or Ray-O-Vac 942SC
056054	12.5	Volt, Eveready Y-1596, Nickel-Cadmium. Rechargeable; ten (10) BH100 Cells in series, with solder tabs on each end.
056055	8.40	Volt, Mercury, Eveready E-146X
*056056	4.05	Volt, Mercury, Burgess H133R, Eveready E133N or Mallory TR133R
056058	1.35	Volt, Mercury, Mallory 303851
056061	6.0	Volt, Eveready 520, Alkaline-Manganese Dioxide Type
056062	9.0	Volt, NEDA 1603 Battery, Eveready No. 276, Burgess D-5, Mallory M-1603 or Rayovac 1603. Snap-type terminals.
056063	1.40	Volt, Mercury Battery. Burgess HG9, Eveready E9 or Mallory ZM9
056064	9.0	Volt, Carbon Zinc Battery, Eveready #246 or Burgess 2N6
056065	+22.5	Volt, +45 Volt Carbon Zinc, Eveready 7625, Burgess 5308, Marathon 6709
056085	1.35	Volt, Eveready E601 Mercury Cell
056086	1.34	Volt, Pyro Service RC135 Mercury Reference Cell
056087		Battery Pack — 7 Cell, #CH-150, Nickel Cadmium Eveready, Stamped 2-N-4301
056088		Battery Pack — 8 Cell, #CH-150, Nickel Cadmium Eveready, Stamped 2-N-4302

For Type K and White Potentiometers

7597 WILLARD LOW-DISCHARGE BATTERY

Characterized by low self-discharge and resultant long life. Designed for use with low current drain applications, the loss of capacity due to local action in the usual type of storage battery has been minimized. They are superior to any of the usual lead cells in regard to stability of voltage, drift and freedom from maintenance.

Type: Willard Low-Discharge, Type DD-5-1

Rating: 2 volts, 200 ampere-hours.

*If carbon zinc battery is required, suggest customer purchase Eveready 333 carbon zinc 4.5 volt battery locally.

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GUARDED D-C CONSTANT VOLTAGE POWER SUPPLY

Produces a constant dc output voltage to a constant load regardless of small line voltage and temperature variations. A replacement for the storage battery or dry cell batteries often used to obtain the standard current required by a potentiometer.

ADVANTAGES

- Eliminates need for frequent standardization
- Completely guarded...electrostatically shielded
- Long term stability of 100 ppm/year

9878	9879
.Temperature coefficient of less than ±2 ppm/deg C	.Temperature coefficient of less than ±5 ppm/deg C
.Exceptional stability: 0.5 ppm per 10 minutes after three hour warmup	.Stability: 5 ppm per hour after two hour warmup

APPLICATION TO L&N POTENTIOMETERS

9878	9879
Used with 7556. *May be used with 7554 and 7555 for more critical (temperature or isolation) applications*	Used with 7554, 7555, 8686-1, 8687-1

<table>
<tr><th>SPECIFICATIONS</th><th>9878</th><th>9879</th></tr>
<tr><td rowspan="2">Input</td><td colspan="2">117 volts ±10%, 50/60 Hz....</td></tr>
<tr><td>6 volt-amperes</td><td>3 volt-amperes</td></tr>
<tr><td>Output</td><td>2.0 volts dc ±2%
at 12.1 mA and at 11.0 mA</td><td>2.0 volts dc ±0.3%
at 12.1 mA</td></tr>
<tr><td>Line Regulation</td><td colspan="2">0.0005% maximum immediate change of output per 10 volt line change (20 to 30 degrees C)
0.001% maximum final change of output per 10 volt line change (20 to 30 degrees C)</td></tr>
<tr><td>Temp Coefficient</td><td>Less than 0.0002% per degree C
(20 to 30 C)</td><td>Less than 0.0005% per degree C
(20 to 30 C)</td></tr>
<tr><td>Maximum Ripple</td><td colspan="2">0.001% RMS (60 and 120 Hz)</td></tr>
<tr><td rowspan="2">Drift (Stability)</td><td colspan="2">At constant temperature and input voltage:
0.01% per year
0.001% per 24 hours</td></tr>
<tr><td>After 3 hour warmup:
0.0002% per hour
0.00005% per 10 minutes</td><td>After two hour warmup:
0.0005% per hour
0.0002% per minute</td></tr>
<tr><td>Max Random Noise</td><td colspan="2">Less than 0.0003% (0.6 Hz to 2K Hz)</td></tr>
<tr><td>AC Isolation</td><td>Output to ground: Less than 8 nanoamperes through a 1 megohm resistor</td><td>Output to ground: Less than 25 nanoamperes, RMS</td></tr>
<tr><td>DC Isolation</td><td>Guard to ground: Greater than 10,000 megohms ★</td><td>Guard to ground: Greater than 500 megohms ▲</td></tr>
<tr><td></td><td colspan="2">★<i>Output to guard with negative (-) terminal connected to guard only: greater than 100 megs</i>
▲<i>At 85% relative humidity (less than 0.2 ppm in terms of measurement inaccuracy when used with Type K potentiometers)</i></td></tr>
<tr><td rowspan="2">Connections</td><td>5-foot shielded line cord with 3-prong plug and a 2-prong adapter with grounding lead. Terminals: a ground terminal and three 5-way output terminals (two positive)</td><td>6-foot shielded line cord with 3-prong plug and a 2-prong adapter with grounding lead. Terminals: two 5-way terminals</td></tr>
<tr><td colspan="2">Negative output terminal is tied to guard internally</td></tr>
<tr><td>Dimensions</td><td>6" L x 6" W x 7-1/4" H (152 x 152 x 184 mm)</td><td>2-9/16" L x 2-9/16" W x 4-7/32" H (65 x 65 x 107 mm)</td></tr>
<tr><td>Weight</td><td>Net about 5 lb (2.3 kg)
shipping about 7 lb (3 kg)</td><td>Net about 1-1/2 lb (0.68 kg)
shipping about 2 lb (0.9 kg)</td></tr>
</table>

(more)

099034 D-C CONSTANT VOLTAGE SUPPLY

IMPORTANT NOTE: For use only with the withdrawn 7553 Type K-3 Potentiometers. *Change in design approximately 5/68 changed output voltage from 3 volts to 2 volts; further modifications included the addition of guarding and guaranteed voltage drift rates with time.*

Specifications same as 9879 except:

Output........2.0 volts dc ±0.3% at 24.44 mA

AUXILIARY EQUIPMENT FOR USE WITH 9878, 9879, AND 099034 POWER SUPPLIES

22-36-11 (836012) Double Shielded Cable for use with 9878, 9879, or 099034 Power Supplies. Cable consists of a pair of twisted polyethylene insulated, untinned stranded copper conductors (equivalent to #22 gauge) with two conductive shields provided with drain wires and insulated from each other with polyethylene insulation. Outside diameter is 0.23".

Outer shield is connected to ground and inner shield is connected to guard (power supply minus).

SERVICING OF 9878, 9879, AND 099034 POWER SUPPLIES

Defective or inoperative units should be returned postage pre-paid to the manufacturer. The date of receipt of the power supply from L&N should be included in the request to examine the defective unit. L&N need not be notified. Schematic diagram, parts list, and replacement parts should be obtained from:

099034 and 9879: Dynage, Incorporated, 1331 Blue Hills Avenue, Bloomfield, Connecticut, 06002.

9878: Instrulab, Incorporated, 1205 Lamar Street, Dayton, Ohio, 45404

9876-M-I LINE-OPERATED D-C POWER SUPPLY FOR PANEL MOUNTING

Specifically designed for use with bridge that requires the connection of an unguarded voltage supply between the junction of its ratio arms and the junction of its balancing and unknown resistance arms.

FEATURES

Large easily read meter scale...indicates magnitude of the dc output voltage
Any output from 0 to 100 can be dialed...full scale on meter
Input and output fuses for overload protection
Completely self-contained for operation on 120 volts, 50/60 hertz

SPECIFICATIONS

Ranges................0 to 10 volts and 0 to 100 volts
Input.................120 volts, 50 to 60 Hz

Max. Current Output...	0 to 10 Volts Range	0 to 100 Volts Range
	800 mA up to 6 volts 100 mA up to 10 volts	20 mA up to 100 volts

Meter Accuracy........	0 to 10 Volts Range	0 to 100 Volts Range
	±0.2 volt	±2.5 volts

Controls.............On-off toggle, range selector toggle, voltage adjustment knob
Dimensions...........5-1/4" (H) x 19" (W) and 7-1/4" (D) (133 x 483 x 184 mm) behind panel
Case.................Metal for panel mounting
Weight...............Net, about 8 lb (3.7 kg); shipping, about 12 lb (5.4 kg).

031□□□ GUARDED LOW-THERMAL KEYS

ADVANTAGES

High quality, guarded, low thermal (less than 0.1 μV).

Variety of models to meet exacting requirements of "dry-circuit", low-level instrumentation.

Easily installed

Easily converted from nonlockdown to lockdown type (loosen cap, depress and turn actuator shaft 1/4 rev, retighten cap).

Performance proven in L&N highest precision instruments.

SPECIFICATIONS

Type _____ see table. Supplied as nonlockdown, key can be easily converted to lockdown type without disassembling. Switch construction features positive keying of stack components to eliminate possibility of shorting.

Contact Assembly Consists of solid gold contacts mounted on beryllium copper spring-blades that are ridged to assure correct flexure and positive contact pressure. The contacts themselves are semi-cylindrical, mounted so that the axes of each pair are at right angles. Design assures a high contact pressure (45 to 75 grams).

Thermals Less than 0.1 microvolt under normal operating conditions.

Insulation Acrylonitrile styrene copolymer, to provide high insulation even under conditions of extreme humidity — better than 30,000 megohms at 95% Relative Humidity between switch circuit and guard

Guard The guard circuit, with terminals, is located between the actuator and the switch circuit to drain off any stray low-level currents.

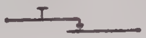
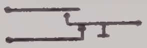
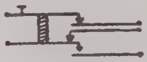
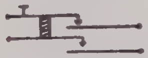
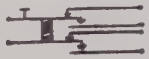
Mounting The actuator shaft of each key mounts at right angles to the panel (1/4" maximum thickmess) through an 0.390" (25/64) hole.

Perpendicular or parallel mounting as specified.

Perpendicular Mounting: Requires approximately 3-1/2" perpendicular clearance, and approximately 1-1/2" side clearance from the center of the mounting hole.

Parallel Mounting: Requires approximately 1-3/4" perpendicular clearance and 2" side clearance.

Pushbutton Gray plastic pushbutton cap.

Type	Contact Arrangement (Key In Up Position)	Part Number	
		For Perpendicular Mounting	For Parallel Mounting
SPST		031187	031166
SPDT		031180 (MB)	—
SPST & SPDT		—	—
DPST		—	—
DPDT		031186 (BM)	031165 (BM)

031□□□, 0312□□ GENERAL PURPOSE UNGUARDED BATTERY AND GALVANOMETER KEYS

ADVANTAGES

Highly satisfactory performance, low cost.

Extensively used in L&N moderate precision instruments.

SPECIFICATIONS

Type *Lockdown or nonlockdown as specified* ___ see table.

Contact Assembly Consists of solid silver contact buttons mounted on tin-plated phosphor bronze spring-arms. The rounded surfaces of the buttons, combined with the configuration of the spring-arms, assure a clean, positive wiping contact.

Thermals Less than 1-microvolt under normal operating conditions.

Construction Contact spring-arms (phosphor bronze) are anchored to the black phenolic body of the key.

Mounting Mounted perpendicular to the panel (3/4" max. thickness) by either of two methods.

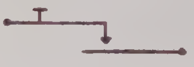
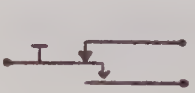
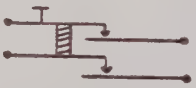
Since the upper end of the switch body is threaded (1/2-20 N.F. 1), the panel can be correspondingly drilled and tapped, and the key screwed into place from the underside of the panel and secured with the locking nut supplied. (For improved appearance, the threaded body can be advanced far enough above the top of the panel to accommodate a knurled nut.)

As an alternative, a hole can be drilled in the panel to accept the threaded body. The key can then be inserted from the underside of the panel, and the assembly secured by the locknut (supplied with the switch) beneath the panel, and a knurled nut (not supplied) on top of the panel.

Pushbutton Phenolic pushbutton cap. *Black or gray as specified.*

OPTIONAL PARTS

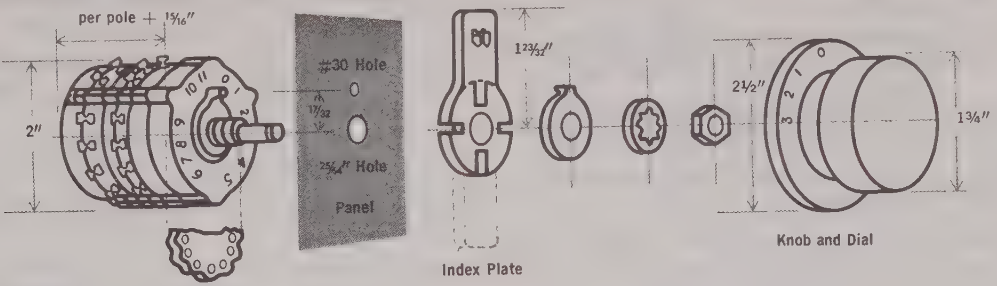
003302 Knurled Nut. To secure key on top of panel.

		Part Numbers			
		Black Pushbutton Cap		Nonlockdown	
Type	Contact Arrangement (Key In Up Position)	Lockdown	Nonlockdown	Lockdown	Nonlockdown
SPST		031011	031015	031291	031290
SPDT		—	—	031014 ▲	031012 ▲
DPST		—	031013	—	—

▲ 031012 and 031014 will have gray pushbutton cap instead of black. Keys with black buttons will be available on special order.

★ Not stocked; available on special order.

L&N ENCLOSED SILVER, SILVER-ALLOY ROTARY SELECTOR SWITCHES 0311□□, 03126□ & 03127□



ADVANTAGES

- Totally enclosed construction, keeps out dust and dirt
- Mechanical stops may be installed in detent plate
- Only two panel holes required for mounting
- Stringent quality checks at all stages of construction
- Initially developed for L&N *top-of-the-line* instruments
- Available as switch only or as complete assembly with knob, dial, and unmarked index

FEATURES

Silver clad contacts and silver-alloy brushes
Contact resistances of less than 0.001 ohm
Contact variations of 0.0005 ohm or less
Thermal emfs of less than one microvolt
Life expectancy of 1,000,000 operations and over

SPECIFICATIONS

Switch Type Wafer; enclosed dust-tight silver, silver-alloy rotary selector switch, make-before-break.

Temperature Range For 12-position switch with bakelite shaft, -65 to +85 C; for other 12 and 16-position switches, -65 to +75 C.

Switch Detent Adjustable by screw, from no detent to stiff operation.

Switch Body Molded, with die-cast aluminum base having bronze bearing insert.

Diameter Approx. 2″, including soldering terminals.

Switch Shaft Supported at both ends. Has stainless steel extension through base for the operating knob, 1/4″ OD with flat.

Depth Behind Panel 15/16″ plus 11/32″ per wafer (two wafers per pole).

Switch Mounting For panel-mounting in 25/64″ hole and #30 aligning hole, spaced 17/32″ between centers. Includes mounting nut, lockwasher and integral aligning pin located at zero switch position.

ELECTRICAL TEST DATA (Series Data Through Switch)

Resistance Less than 0.001 ohm, with variations of ±0.0005 or less.

Conductance Less than 0.0005 micromho.

Max. Inductance Less than 0.03 microhenry.

Current Capacity 1.0 amp breaking, greater than 5 amps carrying (at 120 volts, 60 Hz).

Thermal EMF Less than one microvolt with switch operated at normal speed.

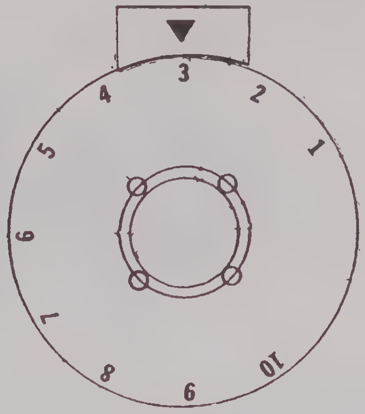
Parallel Data Between Adjacent Switch Points

Points Per Pole	Construction		Insulation Resistance	Capacitance	Voltage Breakdown	Poles	Switch★ Only
	Body	Shaft					
12	Molded alkyd	Line-base bakelite	Greater than 10^{12} ohms when new; greater than 5 x 10^8 ohms after 2 months at 100% relative humidity	Less than 0.5 pf	Greater than 1000 V rms, between switch points or any switch point to ground	1	031105
						2	031106
						3	031107
						4	031108
						5	031109
						6	031110
Switches listed below, having a molded acrylonitrile shaft, are of high quality and are the type used in L&N precision instruments such as the 4393-2 Six-Dial Universal Ratio Set, 4398-M Seven-Dial Double Ratio Set, 7555 (K5) and 7556 (K6) Potentiometers							
12	Lexan	Molded acrylo-nitrile styrene copolymer	Greater than 10^{12} ohms after 2 months at 100% relative humidity	Less than 1.0 pF	Greater than 1500 V rms, between switch points or any switch point to ground	1	031261
						2	031262
						3	031263
						4	031264
						5	031265
						6	031266
16	Molded alkyd	Molded acrylo-nitrile styrene copolymer	Greater than 10^{12} ohms when new; greater than 5 x 10^8 ohms after 2 months at 100% relative humidity	Less than 2.0 pf	Greater than 1000 V rms, between switch points or any switch point to ground	1	031142
						2	031272
						3	031273
						4	031274
						5	031275
						6	031276

★ Order switch, knob, dial, and index as separate items on the order. Do not use Cat. 8256-□ or 8257-□. Knob is 1-3/4″ diameter. Both knob and index are black. The black alumilite dial is 2-1/2″ in diameter and, when numbered, the characters are 3/16″ high in natural alumilite. Directions 177203 show method of assembly for switch, dial, knob, and index.

ACCESSORIES FOR ABOVE SWITCHES.

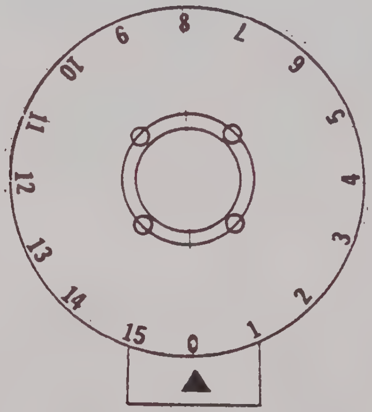
048009	Index - Can be mounted for top reading or bottom reading dials.
124257	Kit - Includes 002007 Knob and 002015 Dial (No markings on dial). Black knob and dial.
002018	Knob and Dial Assembly. Dial is marked 0-10 for bottom reading index. Black knob and dial.
002019	Knob and Dial Assembly. Dial is marked 0-10 for top reading index.
110160	Dial only. Dial is marked 0-15 for bottom reading index. Dial is unfinished aluminum
002007	Knob only. For use with 110160 Dial.
004850	Dial Mounting Screws. Order (4) with 110160 and 002007.



TYPICAL TOP READING
DIAL WITH INDEX

Old Cat. No.	Specify Replacement Switch Part No.
8256-1-☐	031105
8256-2-☐	031106
8256-3-☐	031107
8256-4-☐	031108
8256-5-☐	031109
8256-6-☐	031110
8256-1A-☐	031261
8256-2A-☐	031262
8256-3A-☐	031263
8256-4A-☐	031264
8256-5A-☐	031265
8256-6A-☐	031266
8257-1-☐	031142
8257-2-☐	031272
8257-3-☐	031273
8257-4-☐	031274
8257-5-☐	031275
8257-6-☐	031276

☐ *Formerly used to specify knob and dial — see preceding page.*



TYPICAL BOTTOM READING
DIAL WITH INDEX

ELECTRICAL AND ENVIRONMENTAL HIGHLIGHTS

Life-Temperature Greater than 100,000 rotational cycles at 125°C and low loads.

Contact Resistance Initial contact resistance less than 0.0015 ohm.

0.005 ohm max. change in contact resistance after moisture-resistance and salt-spray tests.

Less than 0.001 ohm change during and after life rotational tests.

Thermal EMF Less than 0.05 microvolt per degree C change in ambient temperature.

Shock Meets or exceeds high and medium impact requirements, per symbol H and M.

Vibration Will withstand 10 to 2000 cycles per second, per symbol 3.

Explosion Proof As tested per Method 109 of MIL-STD 202.

CONSTRUCTION FEATURES

Detent assembly, stops, nuts and washers are constructed of high-quality stainless steel ... in the 300 and 400 Series ... insuring minimum corrosion under adverse conditions.

Unique hex shaft design permits each brush to be offset in 60 degree increments from its normal position.

All switches are factory-lubricated to permit storage and operation over the full temperature span of −65 to +125°C.

SPECIFICATIONS

All switches will have a shaft-extension length of 9/16″ and a bushing length of 3/8″. On all switches, the flat on the shaft will be diametrically opposite the active contact. No stops will be installed, but two stop pins and 177405 Installation Instructions will be provided with each switch.

Type 30 degree detenting gives make before break (shorting) and 60 degree detenting gives break before make (nonshorting); section construction: single shaft, enclosed and dust tight.

Poles One to six (single section per pole); 12 positions per pole. 30 degree detenting gives 11 active positions. 60 degree detenting gives 6 active positions. A collector occupies terminal 12 (12th position) in both cases.

Max. Rated Current (Noninterrupting) 5 amperes.

Contact Resistance Initial contact resistance, 0.0015 ohm; after moisture and salt-spray test, 0.002 ohm; change during and after life rotational test, less than 0.001 ohm.

Thermal Emf Less than 0.05 microvolt per degree °C change in ambient temperature.

Insulation Resistance Initial insulation resistance greater than 10,000 megohms.

Initial Breakdown Voltage 1000 volts ac at atmospheric pressure.

ENCLOSED SILVER ROTARY TYPE SWITCHES

No. Of Poles	New Part Number	Cross Reference To Withdrawn (6/70) Part Numbers
		30° Detenting (Indexing)
1	031561	01-01-(00, or 02 - 12)-01-06-09-12
2	031562	01-02-(00, or 02 - 12)-01-06-09-12
3	031563	01-03-(00, or 02 - 12)-01-06-09-12
4	031564	01-04-(00, or 02 - 12)-01-06-09-12
5	031565	01-05-(00, or 02 - 12)-01-06-09-12
6	031566	01-06-(00, or 02 - 12)-01-06-09-12
		60° Detenting (Indexing)
1	031567	01-01-(00, or 02 - 12)-01-06-09-12
2	031568	01-02-(00, or 02 - 12)-01-06-09-12
3	031569	01-03-(00, or 02 - 12)-01-06-09-12
4	031570	01-04-(00, or 02 - 12)-01-06-09-12
5	031571	01-05-(00, or 02 - 12)-01-06-09-12
6	031572	01-06-(00, or 02 - 12)-01-06-09-12

Capacitance 1 picofarad between any 2 adjacent terminals on one section; 3 picofarads between collectors on adjacent sections.

Temperature Span −65 to +125°C.

Vibration 10 to 2000 cycles per second, per MIL-S-3786C.

Altitude Up to 70,000 feet.

Shock High impact, per MIL-S-3786C.

Angle of Throw 30 or 60 degrees between detented positions.

Weight 0.143 pound for single pole; 0.024 pound for each additional pole.

Stops Two adjustable stops.

Stop Strength Greater than 25 pound-inches.

Terminals Hole accommodates two 0.032″ wires; meets or exceeds pull and solderability test per MIL-S-3786C.

Rotational Torque 1 to 4 pound-inches over temperature span of −65 to +125°C.

Multiple-Leaf Brushes Silver alloy.

Brush (Rotor) Insulation Kel-F.

Section Insulation Diallyl phthalate (glass-filled).

Section Contacts Silver alloy.

Section Terminals Silver alloy (gold-plated).

Shaft and Bushing Stainless steel.

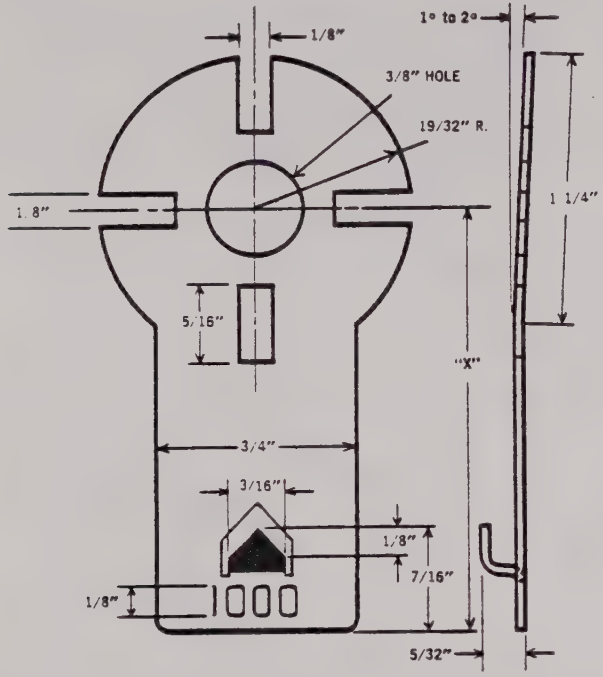
All Other Metallic Parts Stainless Steel (300 and 400 Series).

Bushing Length 3/8″

Shaft Length 9/16″

Shaft Construction Flat on shaft opposite the active contact.

Back is intentionally blank

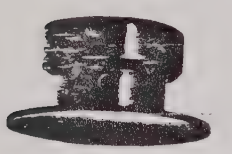


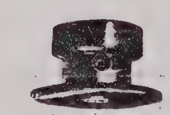
INDEXES: For use with Style A knob and dial combinations.

Indexes are 1/32" aluminum, with black alumilite finish and a natural alumilite pointer. The pointer itself is raised above the surface of the index, so that it is in the same plane as the dial. Indexes with marking (1/8" numerals) can be supplied for bottom of dial reading only. Unmarked indexes can be used in any other position.

FOR USE WITH DIAL SIZE	INDEX DIMENSIONS*	INDEX MARKING	INDEX PART NUMBER
2-1/2" OD Dial	1-23/32"	None	048009
			BOTTOM READING
		10000	048001
		1000	048002
		100	048003
		10	048005
		1	048004
		.1	048006
		.01	048007
		.001	048008
		.0001	048010
2" OD Dial	1-15/32"	None	048055

*From center line of center-hole to outer index edge


Style A


Style B

Style C

KNOBS... Highly polished, molded black or gray plastic with a brass insert drilled and tapped for set screw) to mount on a 1/4" OD shaft. Can be supplied with a white dot near circumference for use with a function or range switch.

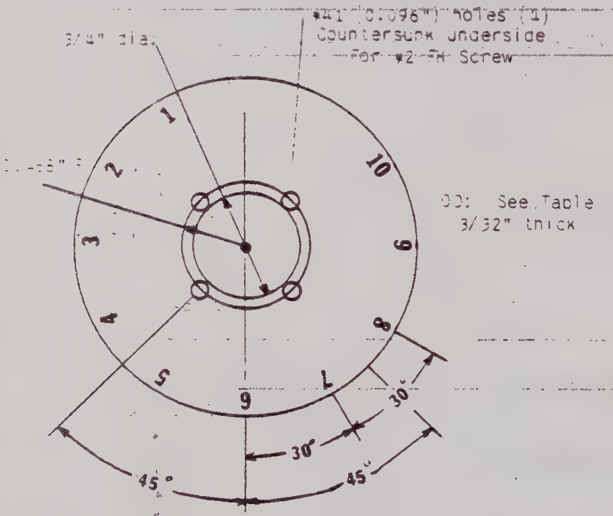
STYLE A: Holes drilled in base to permit fastening a screw-mounted dial if desired.

STYLE B: With an insert designed for a roll-fit into the center hole of an appropriate dial.

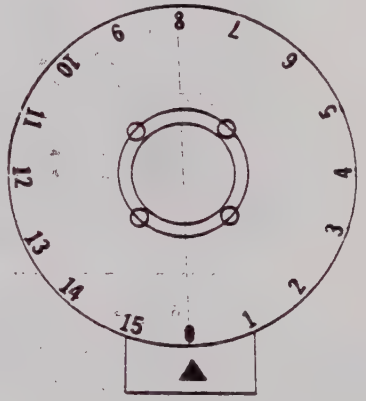
STYLE C: Designed for use without dial

DIALS... Either natural alumilite (medium luster) or black alumilite finish. Can be engraved on special order with numbers, symbols, etc.

STYLE A DIALS...DRILLED HOLES (4) FOR SCREW MOUNTING


#41 (0.096") holes (4)
Countersunk underside
For #2 FH Screw
3/4" dia.
1-1/8" D
OD: See Table
3/32" thick
1
2
3
4
5
6
7
8
9
10
30°
30°
45°
45°

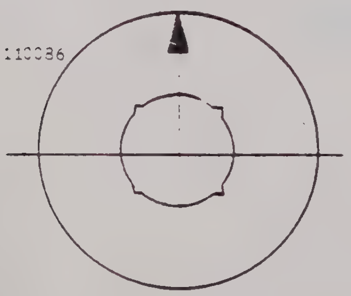
002017 DIAL: 0-10 Counter-Clockwise (CCW) over 300°. Top-Reading. *(See table.)*
If index is desired, see top reading.


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

110160 DIAL: 0-15 Counter-Clockwise (CCW) over 360°. Bottom-Reading. *(See table.)*
Index must be ordered separately.

STYLE B DIALS, ROLL-FIT

110036



1-5/8" or 1-3/8" diameter, 1-16" thick.
See table for ID (0.297" or 0.672")

STYLE A KNOBS AND DIALS *(Indexes are separately ordered)*

KNOB ONLY COLOR	KNOB ONLY MARKING ♦	KNOB ONLY PART NO.	DIAL ONLY FINISH	DIAL ONLY MARKING ●	DIAL ONLY ROTATION	DIAL ONLY PART NO.
KNOB: 2-1/4" x 1-1/2" HIGH			**OD: 3-1/8"...***USE ANY 3-1/8" DIAL FOR ANY 2-1/4" KNOB*			
			Black	None	- -	002125 ▲
			Natural	None	- -	110111 ★ ▲
Black	None	002123 ▲	Black	0-5 (30°) CW, Top	CCW	110102 ▲ (d)
Gray	None	002224 ★ ▲	Black	0-10 (30°) CW, Top	CCW	110103 ▲ (d)
			Natural	0-X & X-0 (30°) Bottom	- -	110096 ▲ (a)
			Natural	0-20 & 20-0 (15°) Bottom	- -	110094 ▲ (b)
KNOB: 1-3/4" OD x 1-1/4" HIGH			**OD: 2-1/2"...***USE ANY 2-1/2" DIAL DESIRED FOR ANY 1-3/4" KNOB*			
			Black	None	- -	002015 ▲
			Natural	None	- -	110097 ▲
Black	None	002007 ▲	Black	0-9 (30°) CW, Top	CCW	110098 ▲ (c)
Black	Dot 150° rt (uses 002007)	002100 ▲	Black	0-10 (30°) CW, Top	CCW	110058 ▲ ✚ (c)
			Black	0-10 (30°) CW, Top	CCW	110074 ▲ (d)
Gray	None	002205 ▲	Black	0-10 (30°) CCW, Top	CW	002017 ▲ ✚ (c)
Gray	Dot 180° (uses 002205)	002246 ▲	Black	0-10 (30°) CCW, Bottom	CW	002016 ▲ ✚ (c)
			Natural	0-15 (22.5°) CCW, Bottom	CW	110160 ▲
			Black	0-100 (31.5°) CCW, Top	CW	002154 ▲
KNOB: 1-3/8" x 1-1/16" HIGH			**OD: 2"...***USE ANY 2" DIAL DESIRED FOR ANY 1-3/8" KNOB*			
Black	None	002124 ▲	Black	None	- -	002126 ▲
Gray	None	002204 ▲	Natural	None		110168 ▲
Gray	Dot 180° (uses 002204)	002198 ▲	Natural	0-10 (30°) CCW, Bottom	CW	110163 ★ ▲
			Black	0-15 (22.5°) CCW, Bottom	CW	110047 ▲
Gray	Dot 0° (uses 002204)	002236 ▲	Natural	0-15 (22.5°) CCW, Bottom	CW	110169 ▲
			Black	0-50 (30°) CCW, Top	CW	110138 ▲

♦ *Dots, when listed, are located near circumference at indicated angular degrees from set screw. (For Style A, set screw is located 45° from screw holes.)*

● *Column indicates angular degrees between numerals, clockwise or counter-clockwise and top or bottom reading. (For Style A, numeral starting point is located 45° from screw holes.)*

▲ *When knob and/or dial are ordered as individual part numbers, screws for mounting knob to dial are* *__not__* *included. (Screws are included only whan an assembly number is indicated, see ✚). For each knob and dial unit ordered, specify separately: Four 004850 Screws; 5/16", #2 pH. FH Thread Cutting, Type 25 Shakeproof.*

★ *IMPORTANT...Consult EIC, for minimum order quantities*

✚ *Assemblies, including mounting screws, are available as follows:*

002018 ...*Knob & Dial Assy; includes* 002016 *Dial and* 002007 *Knob*
002019 ... " " " " 002017 " " "
002184..... " " " " 110058 " " "
002206..... " " " " 110086 " and 002201 Knob; index pointer located 180° from set screw.
002228..... " " " 110086 " and 002201 Knob; " " " 30° from right of set screw.

Contact Lab Equipment Division for minimum order quantities of the following:
002270...Knob & Dial Assy; includes 110201 Dial and 002201 Knob
002271... " " " " 110180 " " 002201 "

(a) *"X" corresponds to "10" etc; red (outer) and black (inner 0-X) 5/32" numerals*

(b) *Red (outer) and black (inner 0-20) 5/32" numerals*

(c) *1/8" numerals*

(d) *3/16" numerals*

STYLE B KNOBS AND DIALS

KNOB ONLY			DIAL ONLY			
COLOR	MARKING ♦	PART NO.	FINISH	MARKING ●	ROTATION	PART NO.
KNOB: 1-1/8" OD x 7/8" HIGH			**OD: 1-5/8"...*ID VARIES, USE APPROPRIATE STYLE B KNOBS (SEE NOTES)***			
Black	None	002121 (e)	Black	None	- -	002127 (e)
Black	Dot 150° left *(uses 002121)*	002185 (e)				
			Natural	Index Pointer	- -	110086 + (f)
Gray	None	002201 (f) (g)	Natural	0-10 (30°) CCW, Bottom	CW	110201 ★ (f)
			Natural	1-11 (30°) CCW, Bottom	CW	110180 ★ (f)
KNOB: 7/8" OD x 25/32" HIGH			**OD: 1-3/8"...*USE APPROPRIATE STYLE KNOB***			
Black	None	002119 (e)	Black	None	- -	002128 (e)
Gray	None	002208 (e)				

STYLE C KNOBS

KNOB ONLY		
COLOR	MARKING ♦	PART NO.
KNOB: 1-1/8" OD x 7/8" HIGH		
Black	None	002122
Gray	None	002202
KNOB: 7/8" OD x 25/32" HIGH		
Black	None	002120
Gray	None	002200
Gray	Dot 50° right *(uses 002200)*	002215

♦ *Dots, when listed are located near circumference at indicated angular degrees from set screw. (For Style A, set screw is located 45° from screw holes.)*

● *Column indicates angular degrees between numerals, clockwise or counter-clockwise and top or bottom reading. (For Style A, numeral starting point is located 45° from screw holes.)*

▲ *When knob and/or dial are ordered as individual part numbers, screws for mounting knob to dial are* *__not__* *included. (Screws are included only when an assembly number is indicated, see +.) For each knob and dial unit ordered, specify separately: Four 004850 Screws; 5/16", #2 Ph. FH Thread Cutting, Type 25 Shakeproof.*

+ *Assemblies, including mounting screws, are available as follows:*
002018 ...*Knob & Dial Assy; includes* 002016 *Dial and* 002007 *Knob*
002019 ... " " " " 002017 " 002007 "
002184..... " " " " 110058 " 002007 *"*

002206..... " " " " 110086 " 002201 Knob; index pointer located 180° from set screw.
002228..... " " " " 110086 " 002201 Knob; index pointer located 90° from right of set screw.

Contact Lab Equipment Division for minimum order quantities of the following:
002270...Knob & Dial Assy; includes 110201 Dial and 002201 Knob
002271... " " " " 110180 " 002201 "

(e) *Knob has 0.296" projection for 0.297" ID-starred dial*

(f) *Knob has 0.671" projection for 0.672" ID-starred dial*

(g) *Set screw not included when knob only is ordered. (If required, specify 3/16" 6-32 socket Hd Cup Point Set Screw.)*

FEATURES...BINDING POSTS

Acrylonitrile styrene copolymer insulators...provide an insulation resistance of 10^{12} ohms or better...even under adverse conditions.

Position locked...studs key into insulators which are shaped to lock in keyed panel holes.

Ridged stud shoulder...prevents leadwire "walking" when head is tightened.

Fit panels up to 3/8" thick.

INSULATED, UNGUARDED BINDING POST KITS

KIT NO.	HEAD COLOR	STUD MATERIAL	CONSTRUCTION
124275 124306	Gray Black	Gold-plated Copper	The post assembly consists of a stud centered in two insulators mounted above and below the panel. The upper end of the stud is threaded to accept the head, the lower end is threaded for the nut (and washers) which lock the assembly together and has a capstan style end for wrap-around, soldered terminal connections.
124276 124307	Gray Black	Constantan	
124277 124308	Gray Black	Iron	

Used in L&N instruments for thermocouple measurements — 8692 and 8693 Thermocouple Indicators, 8690 and 8691 Portable Millivolt Indicators, etc.

INSULATED, GUARDED BINDING POST KITS

Designed for those applications where guarding is critical to drain off stray currents which might affect measuring circuits.

KIT NO.	HEAD COLOR	STUD MATERIAL	CONSTRUCTION
124274 124305	Gray Black	Gold-plated Copper	The stud assembly comprises a gold-plated copper stud centered in, and insulated from, a threaded nickel-plated brass guard-sleeve. Insulating material is acrylonitrile, and stud, sleeve and insulation are molded into an integral unit. Centered in two insulators, one above and one below the panel, the stud assembly is locked in position by a hex nut which threads on the guard-sleeve. A guard ring above the hex nut provides a guard-circuit terminal connection. The terminal end of the post is slotted for a wrapped and soldered connection.

Used in L&N instruments such as precision potentiometers, the Guarded Wheatstone Bridge, etc.

GROUNDED, UNGUARDED BINDING POST KITS

Provide a uniformity of top plate appearance when used with the insulated and guarded posts (124274 or 124305).

KIT NO.	HEAD COLOR	STUD MATERIAL	CONSTRUCTION
124279 124309	Gray Black	Gold-plated Copper	Comprise a gold-plated copper post centered in an insulator mounted above the panel. The upper end of the stud is threaded to accept the head, the lower end threaded for the nut (and washers) which lock the assembly together and ground the post to the (metal) panel. The capstan form of the lower end is for wrap-around, soldered terminal connections.

BINDING POSTS...UNGUARDED, GENERAL PURPOSE, FOR INSULATED PLATES OR PANELS

For general purpose applications, where leakage is not critical and guarding is not required.

FEATURES

Components separately ordered...provide versatility of numerous combinations.

Fit insulated panels up to 3/4" thick...bakelite, rubber, vinyl, etc.

MOUNTING

For each assembly, two holes are drilled in the panel, 7/32" apart - a #9 (0.196") hole for the brass mounting screw (stud), a #27 (0.144") hole for the extended terminal of the contact-punching. The mounting screw threads through the ring of the punching, anchoring it in its phenolic base on the upper side of the panel. The head threads on the end of the mounting screw.

COMPONENT PARTS...ORDER SEPARATELY

COMMON PARTS (One of each required)		PUNCHING (One required)		MOUNTING SCREW (One required)	
DESCRIPTION	PART NO.	MATERIAL	PART NO.	PANEL THICKNESS	PART NO.
Head (Black)	042015	Brass	016076	3/16"	004041
Base (Black)	118031	Constantan	016078	1/4"	004042
Washer	001024	Copper	016079	3/8"	004043
Lock Washer	001108	Iron	016080	1/2"	004044
				5/8"	004045
				3/4"	004046

OIL

090014 D.T.E. Light Oil. 1 pt.

For resistance standards, oil immersed switches, etc.

An oil which has been found to be superior to some of the essential qualities of power factor, oxidation and acid content.

090019 CRAMOLIN

PLUGS FOR RESISTANCE BOXES AND BRIDGES

Type L plugs are for 4230 Anthony-Pattern Wheatstone Bridge. Finish can be brass or nickel plate, as specified.

033034 **Type L Plug**
(Std 16-L)

107001 **Thermal Free Solder, Two Feet**
(107-1-0-1)

Includes Directions 77-39-0-7

REPLACEMENT DETECTORS, STANDARD CELLS AND POWER SUPPLIES FOR L&N INSTRUMENTS

FOR DESCRIPTION OF BATTERIES OR POWER SUPPLIES, SEE 10.8-1

The ( ) number preceding the battery part number indicates the quantity required.
NOTES 1, 2, 3, 4, 6 and 7. . .See end of listing.

CATALOG NUMBER	GALVANOMETER SYSTEM OR DETECTOR	STANDARD CELL	CONSTANT VOLTAGE SUPPLY OR BATTERY
1206	(PI–29–c) 354002	––	––
2320	[1]PI–24–☐	––	––
2322	[1]PI–24–☐	––	––
2340	[2]06211☐	––	––
2430	[2]PI–195–☐	––	––
2435	[2]06210☐	––	––
2440	2448	––	––
2450	2458	––	––
2470	2475–☐	––	––
4270	(PI–24–c) 354051	––	––
4282	(PI–24–c) 354051	––	(1) 056001
4283	062112	––	(2) 056012
4285	2314–b	––	––
4286	(PI–24–e) 354053	––	(2) 056001
4287	062103	––	(3) 056004
4287–2	2437–2–10	––	(1) 056028
4287–3	324190	––	(1) 056004, (2) 056021
4288	062112	––	(4) 056025
4289	062103	––	(2) 056004, (1) 056009
4289–1	External Accessory	––	(1) 056021
4289–2	2437–2–10	––	(3) 056053
4289–3	324190	––	(1) 056009, (2) 056021
4959	062113	––	(1) 056021
5300	(PI–24–c) 354051	––	(3) 056012
5305	(PI–24–c) 354051	––	(3) 056012
5365	(PI–24–b) 354050	––	––
5430–A, –AM, –AM–1	(PI–24–c) 354051	––	(3) 056012
7565	––	––	(2) 056017
7652	––	(PI–127) 130000	––
7654	(PI–24–d) 354052	(PI–127) 130000	––
[3]7655	(PI–24–d) 354052	(PI–127) 130000	056001
7656	(PI–24–b) 354050	(PI–127) 130000	056001
7657	––	(PI–127) 130000	––
7659	2314–c	Discontinued	(8) 056012
7669	––	––	(3) 056001
7960	––	130000	––
8015★	PI–24–☐	––	(2) 056001
8016	2314–b	––	(1) 056001
8017	062112	––	(2) 056012

★ The suffix for the galvanometer system used in these instruments depends on the range change in ohms and the type of Thermohm. (See Conversion Tables 77-21-0-4). The suffix is determined from the following data:

Suffix	Thermohm Ω	Range Change Ω
b	10, 25	above 3
e	100	6.5 to 12.5

REPLACEMENT DETECTORS, STANDARD CELLS AND POWER SUPPLIES (Cont.)

CATALOG NUMBER	GALVANOMETER SYSTEM OR DETECTOR	STANDARD CELL	CONSTANT VOLTAGE SUPPLY OR BATTERY
8025	2314–A	——	(2) 056001
8057	——	——	(2) 056001
8062	(PI–102–b–1) 354026	——	(3) 056001
8064, 8064–A	062102	——	(3) 056004
8064-1, 8064-A1	External Accessory	——	(1) 056004
[4] 8064-2, 8064-A2	2437-2-10	——	(1) 056004, (2) 056053
[4] 8621 to 8623	021006	130000	(4) 056012
[4] 8626-c	021006	130000	(4) 056012
[4] 8631 to 8633	——	130000	(6) 056012
[4] 8636-c	——	130000	(6) 056012
8652 to 8654	——	130000	——
8656 to 8659	(PI–24–b) 354050	Discontinued	(1) 056001
8662	(PI–102–b–1) 354026	130001	(3) 056001
8667	(PI–24–b) 354050	130000	(1) 056001
8671 to 8676	——	130000	(1) 056001
8686	062102	130031[7]	(3) 056004
8686-1	External Accessory	Constant Voltage	9879
8686-2	2437-2-10	130031[7]	(2) 056053, (1) 056004
8686-3	324190	——	(1) 056004, (2) 056021
8687	062103	130031[7]	(1) 056021[6], (2) 056004
8687-1	External Accessory	Constant Voltage	9879
8687-2	2437-2-10	130031[7]	(2) 056053, (1) 056021[6]
8687-3	324190	——	(3) 056021[6]
8690	062112	130031[7]	(1) 056004[6]
8690-1	External Accessory	Constant Voltage	(1) 099019
8690-2	021177	130031[7]	(2) 056056, (1) 056004
8691	062112	130031[7]	(1) 056004
8691-1	External Accessory	Constant Voltage	(1) 099019
8691-2	021177	130031[7]	(2) 056056, (1) 056004
8692	062111	130031[7]	(1) 056004
8692-1	External Accessory	Constant Voltage	(1) 099012
8692-2	021177	130031[7]	(2) 056056, (1) 056004
8693	062111	130031[7]	(1) 056004
8693-1	External Accessory	Constant Voltage	(1) 099012
8693-2	021177	130031[7]	(2) 056056, (1) 056004
8694 to 8696	062112	130035[7]	(2) 056012
8697	062113	130031[7]	(10) 056012
9847, 9848	(PI–24–c) 354051	——	——
9912, 9912-1	——	——	(1) 056012

NOTES

[1] For characteristics, see page: 10.7-3-9

[2] For characteristics, see specs for catalog number

[3] Standard Cell is not available for 7655, serial numbers below 299366.

[4] 862□, 863□ Optical Pyrometer: 026050. . .Standard Lamp, 1948/1968 IPTS Calibration.

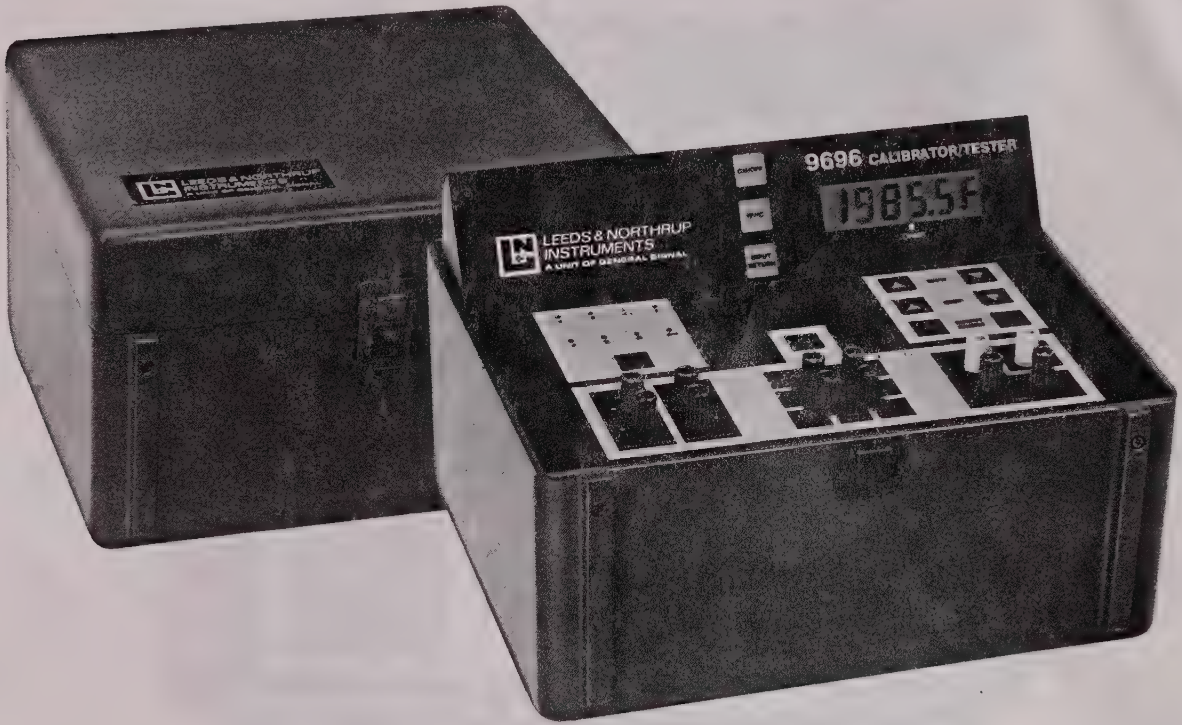
[6] Specify separately 003320 Binding Post Heads (2) to replace insulated heads

[7] 130031 and 130035 Standard Cell Assemblies include 130007 Standard Cell

STANDARD CELLS FOR SELF-CONTAINED POTENTIOMETERS

130000 (PI–127)	UNMOUNTED STANDARD CELL. Range: 1.0188 to 1.0198 absolute volts
130001 (PI–169)	UNMOUNTED STANDARD CELL. Range: 1.01884 to 1.01964 absolute volts

L&N Model 9696 Calibrator/Tester

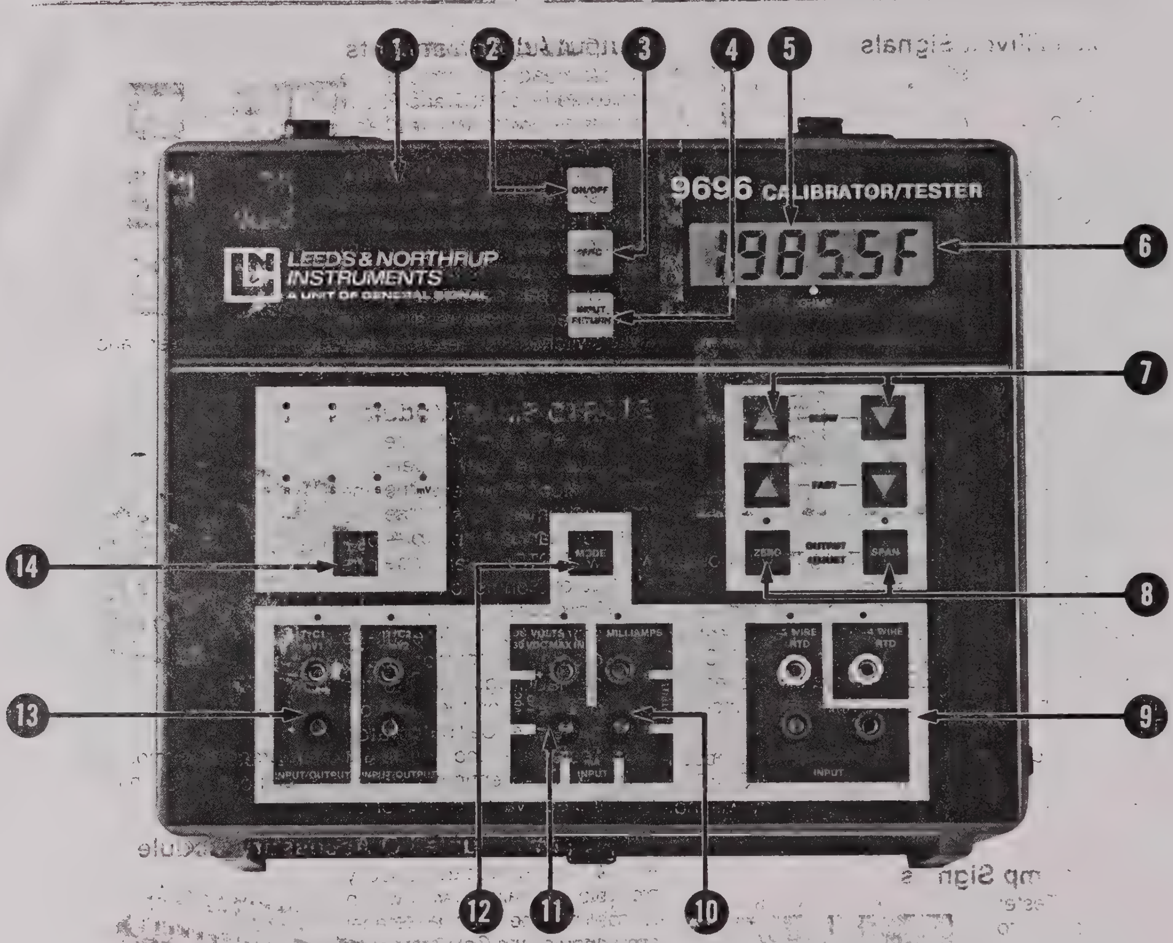


A multiple-function instrument designed for calibrating and testing recorders, controllers and transmitters

- **Accurate to .03% of span**
- **Microprocessor-Based**
- **Occlusive Membrane Switching**
- **Input and Output J,K,T,E,R,S,B, thermocouple signals**
- **.1° Resolution for thermocouples**
- **Input and Output RTD's, mA, mV, VDC**
- **.001 Resolution for mA, mV, VDC**
- **Large ¾″ LCD Display**
- **Rugged, portable housing**

The L&N 9696 Calibrator/Tester is a lightweight, accurate tool for making lab or field calibrations and troubleshooting all types of recorders, controllers and transmitters. The 9696 instrument provides the means to quickly and simply input and output thermocouples and RTDs, as well as mA, mV, and VDC signals, allowing it to be used in a wide variety of applications.

The L&N 9696 Calibrator/Tester employs a single-chip microprocessor which enables it to perform up to 89 linearization segments of thermocouple calibrations, providing very close conformity to NBS curves as close as +/− 0.03% of span. This accuracy is sustained over the complete range of all the standard thermocouples covered by the instrument. A unique system for reference junction compensation provides accurate input


1
2
3
4
5
ON/OFF
9696 CALIBRATOR/TESTER
°F/°C
1985.5F
6
LEEDS & NORTHRUP INSTRUMENTS
A UNIT OF GENERAL SIGNAL
INPUT RETURN
7
SLOW
FAST
14
MODE
ZERO
OUTPUT ADJUST
SPAN
8
VOLTS
30 VDC MAX IN
MILLIAMPS
3 WIRE RTD
4 WIRE RTD
13
9
INPUT/OUTPUT
INPUT/OUTPUT
INPUT
INPUT
12
11
10

1. Tilt-up Display Panel
2. On/Off Membrane Switch
3. °F/°C Selector Switch
4. Return To Input Mode Switch
5. ¾" High LCD Display
6. Display Annunciators
7. Increase/Decrease Output Adjustments
8. Zero and Span Output Selectors
9. 3 or 4 Wire RTD Connection Terminals
10. Milliamp Input/Output Terminals
11. DC Voltage Input/Output Terminals
12. Operating Mode Selector
13. TC/mV Input/Output Terminals
14. TC/mV Calibration Selector Switch

and output readings over a wide operating range of −10°C to 55°C ambient temperature. Resolution of temperature readings is .1°F or C. With the mV, VDC or mA functions, resolution is .001 and .01 ohms for RTD resistance measurements.

The switching arrangement incorporated in the 9696 Calibrator/Tester has all functions accessed and controlled by readily identifiable membrane switches, with LEDs and an audible "beep" confirming the switch action and operating mode selection. The membrane switch panels seals the instrument's electronics from the environment while providing over one million actuations per switch.

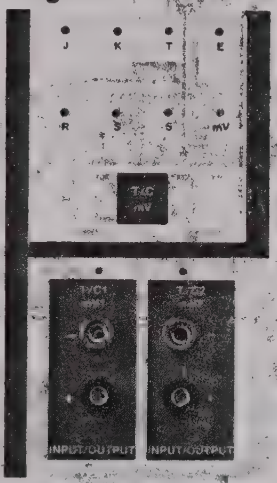
With seven standard NBS thermocouple calibrations (J,K,T,E,R,S,B), plus mV, VDC and mA functions, and ohms for 3 or 4 wire RTDs, the Calibrator/Tester can be used to calibrate and check out most industrial process instruments. A light but rugged housing with a built-in carrying handle allows it to be taken anywhere in the field. An optional nylon carrying case with space for accessories makes transporting the Calibrator/Tester even easier. And with up to 12-hour continuous operation available from the rechargeable batteries, a full day's work in the field is no problem.

Operation

The 9696 Calibrator/Tester is easy to operate. All common functions are grouped together on the membrane switch pad. To start operating, simply depress the on/off switch. The ¾" LCD display activates and you're ready to proceed. This display can be tilted to a 60° angle for easier viewing when the instrument is being used in a flat position on a table or bench.

Immediately below the on/off switch is a switch for selecting either °F or °C when thermocouples are to be measured or simulated and below that a switch for returning to the input mode after using the output functions.

Thermocouple/Millivolt Signals

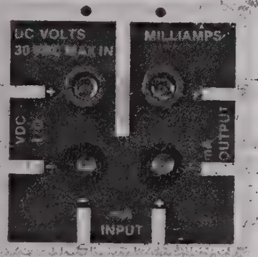


If thermocouple or millivolt signals are to be checked, the T/C1 and T/C2 or mV1 and mV2 input/output connectors on the front panel are used. The pairs allow simultaneous connection of two thermocouple or millivolt sources for measurement. The instrument can also be used as a precision calibrator in its output mode, providing calibrated mV signals to simulate thermocouple outputs for any temperature over the operating range. For example, a range of −32°F to 2000°F representative of a Type J thermocouple, can be simulated in the output mode by adjusting the output to the desired temperature on the display.

The area above the thermocouple and millivolt terminals on the face panel is used to select the proper thermocouple (or millivolt) input or output. Each time the "T/C mV" switch is depressed, the LED annunciator moves sequentially to the right through all eight calibration functions (J,K,T,E,R,S,B, plus mV).

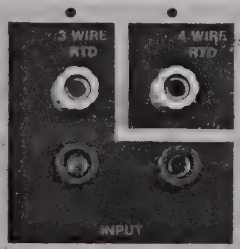
If over-range or under-range conditions are encountered during operation, the display will read HI or LO. In the case of an open thermocouple, the display will indicate "------".

DC Voltage/Milliamp Signals



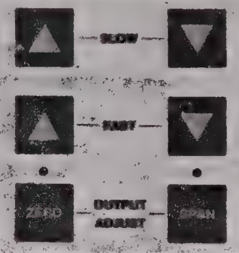
The 9696 Calibrator/Tester also has the capability to measure inputs and provide outputs of DC voltage and milliamps, so that a variety of transmitters, pressure transducers and other non-temperature process instruments can be calibrated or checked. DC voltage input range is −9.99 to 30 VDC; output is 0 to 10 VDC. Milliamp input range is −9.99 to 90 mA; output is 0 to 50 mA. Two-wire, 24-volt DC transmitters can be powered by the Calibrator/Tester while their output is being checked, eliminating the need for a separate power supply.

RTD (Resistance) Measurements



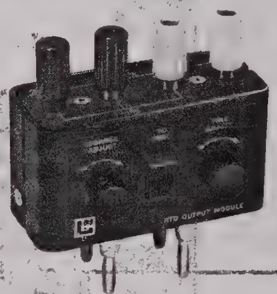
The 9696 Calibrator/Tester is equipped to make 3-lead or 4-lead RTD measurements over the range of 0 to 700 ohms with 0.01 ohm resolution. Since the measurement is made directly in resistance values (ohms), the instrument can be used with any type of RTD (platinum, copper or nickel) using the appropriate resistance/temperature table for the RTD being measured.

Output Adjustments



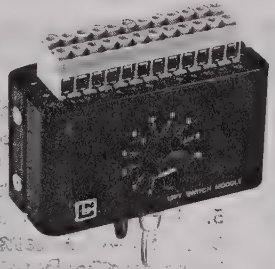
All output adjustments are made via FAST and SLOW increase switches and FAST and SLOW decrease switches which allow coarse and fine tuning. There are also switches for individually setting a zero and a span value. The zero and span points can be recalled by depressing the switches, so there's no need to repeatedly set a zero and a span value when calibrating an instrument.

RTD Simulator Module

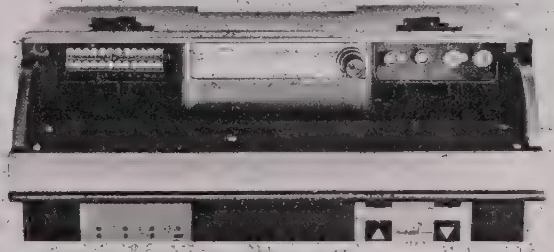


An RTD Simulator Module supplied with each Calibrator/Tester enables the instrument to simulate the resistance output of 3 or 4 wire RTDs over the range of 18.0 ohms to 500 ohms. This module, which is stored behind the tilt-up display panel for ready availability, plugs into the RTD terminals on the front panel of the Calibrator/Tester. Coarse and fine potentiometers on the module permit adjustment of the resistance output to 0.01 ohms, the equivalent of .1°F or C.

Thermocouple I/O Accessory Module



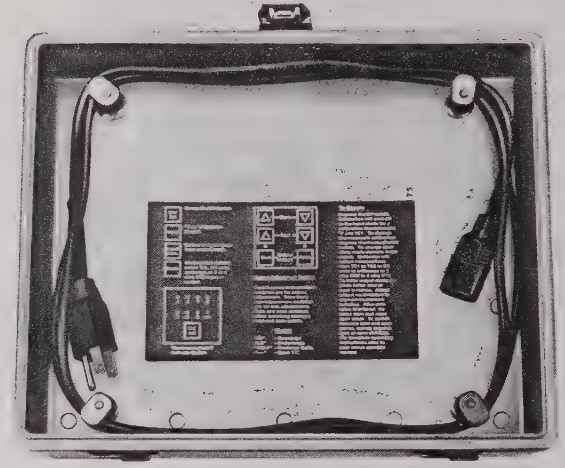
An optional accessory module is available which plugs into the front panel and enables the Calibrator/Tester to accept inputs or provide outputs for up to 12 thermocouples or mV devices. Point selection is made via a rotary switch on the front of the module, while wiring terminations are made at readily accessible screw terminals on the top. This accessory can be useful in speeding up extensive surveys of temperature points, or in calibrating or troubleshooting multiple instruments. Like the RTD Output Module, the Thermocouple I/O Accessory Module is stored behind the display panel for easy access.

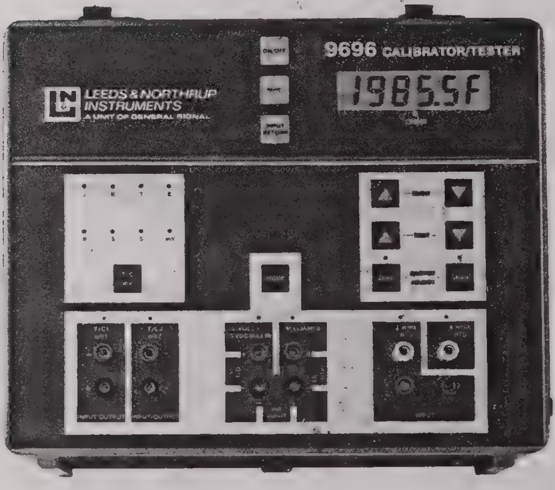


Underneath the tilt-up display panel is space for storing both the RTD Simulator Module and the optional Thermocouple I/O Accessory Module.

Battery-Pack

The Calibrator/Tester is powered by a rechargeable lead-acid battery-pack which provides up to 12 hours of continuous operation. These batteries can be quick-charged to 90% of capacity in only 8 hours so that a hookup to line voltage overnight prepares the instrument for field use the next day (charging to 100% of capacity takes 18 hours). No special battery charger is needed. Simply connecting the cord stored in the cover between the gasketed receptacle on the side of the housing and a 115 VAC outlet is all that's required. To warn of low battery power, when 30 minutes of battery life remain an intermittent "beeping" sound can be heard which increases in intensity as the batteries drain. When the batteries are at the point where they must be recharged if the instrument is to continue operating, the display will read HELP. The Calibrator/Tester can also be operated at any time directly from line voltage.





Inside the cover of the 9696 Calibrator/Tester is a legend plate with operating information, plus an electrical cord for recharging the battery or operating from line voltage.

An optionally available nylon carrying case for the 9696 Calibrator/Tester contains side pockets for storing accessory modules and incidental tools.

Accuracy Table

Thermocouple Calibration	Temperature Range (Degrees)	Resolution (Degrees)	Conformity IPTS-68 (Degrees)	Overall Accuracy (Degrees)	Overall Accuracy as % of Span
J	−320 to 2000 °F	0.1 °F	.20 °F	± 0.7 °F	± .03%
	−196 to 1094 °C	0.1 °C	.10 °C	± 0.4 °C	± .03%
K	−310 to 2500 °F	0.1 °F	.20 °F	± 0.9 °F	± .03%
	−190 to 1371 °C	.01 °C	.10 °C	± 0.5 °C	± .03%
T	−330 to 750 °F	0.1 °F	.20 °F	± 0.8 °F	± 07%
	−201 to 398 °C	.01 °C	.10 °C	± 0.4 °C	± .07%
E*	−320 to 1830 °F	0.1 °F	.20 °F	± 0.9 °F	± .04%
	−196 to 999 °C	0.1 °C	.10 °C	± 0.5 °C	± .04%
R	30 to 3200 °F	0.1 °F	.20 °F	± 1.7 °F	± .05%
	−1 to 1760 °C	0.1 °C	.10 °C	± 0.9 °C	± .05%
S	30 to 3200 °F	0.1 °F	.20 °F	± 1 7 °F	± 05%
	−1 to 1760 °C	0.1 °C	10 °C	± 0 9 °C	± 05%
B	1000 to 3300 °F	0.1 °F	25 °F	± 1.8 °F	± .08%
	538 to 1815 °C	0.1 °C	.14 °C	± 0 9 °C	± 07%
mV**	−9.99 to 90.00 mV	001 mV	-NA-	± .01mV	± 01%
mA**	−9.99 to 90.00 mA	.001 mA	-NA-	± 01mA	± 01%
RTD***	0 to 700 ohms	.01 ohm	-NA-	± 10 ohm	± .015%

**1450°F, 788°C output limit on E ranges*
***60.00 mV output limit on millivolt range; 50.00 mA output limit on milliamp range.*
****RTD output using simulator is 18.0 ohms to 500 ohms*
Note: Accuracies shown are based on tests at 25°C

GENERAL SPECIFICATIONS

Ambient Operating Temperature: +10°C to 55°C.

Normal Mode Rejection: 50 db

Common Mode Rejection: 125 db, when operating on AC voltage

Battery Pack: 6 cell lead acid, rechargeable, 2.5 amp hours, 12V nominal

Battery Life: Normal input operation thermocouple or mV output 10-12 hours continuous, mA or volts output 4-6 hours continuous

Battery Charger: Integral with unit, 115 VAC

Battery Charger Time: 8 hours 90% charge, 18 hours 100% charge

Battery Discharge Indicator: Early warning — unit emits audible beep

Final warning — Unit displays "HELP" for one minute then shuts off

Overrange: Unit displays "HI"

Open T/C: Unit displays - - - -

Underrange: Unit displays "LO"

Legend: Thermocouple — unit displays "F" or "C"

Volts and millivolts — unit displays "E"

Milliamps — unit displays "A"

Display: 0.75" LCD 6 digit display (6th digit legend) Leading zeros blanked "−" sign left of leading digit

Function Switching: Membrane with audible and visual feedback

Membrane Switch Material: Polycarbonate/silver contacts

Case Material: Rigid urethane UL 94V0 high density

Case Finish: Polyurethane paint

Case Dimensions: 12" wide × 10" high × 7.5" deep (including cover)

Weight: 13 lbs. (including cover and line cord)

THERMOCOUPLE INPUT MODE

Resolution: 0.1°F all ranges

Input Leakage Current: 10 nanoamperes maximum

Source Resistance Effects: 1 µV error/100 ohms source resistance

Input Impedance: 100 megohms minimum

Span Drift: 25 ppm/°C of reading

Zero Drift: .23 µV/°C

Reference Junction Compensation Error:
0.02 deg/deg J,K,T,E, calibrations
0.05 deg/deg R,S,B, calibrations

THERMOCOUPLE OUTPUT SOURCE MODE

Range: All thermocouple ranges listed (−12 mV to 100 mV adjustable)

Adjustment: Coarse and fine membrane switches for continuous adjustment over entire span

Source Mode: Characterized and compensated output to simulate thermocouples

INPUT MILLIVOLT MODE

Range: −9.990 mV to 90.000 mV
Resolution: 0.001 mV (1 µV)
Accuracy: ± .01 mV (10 µV)
Input Leakage Current: 1 µV error/100 ohms source resistance
Input Impedance: 100 megohms
Span Drift: 25 ppm/°C of reading
Zero Drift: 0.23 µV/°C

OUTPUT MILLIVOLT MODE

Range: −9.900 mV to 90.000 mV continuous adjustment
Adjustment: Coarse and fine membrane switches for adjustment over entire span with 1 µV resolution

Output Impedance: 10 ohms

RTD INPUT MODE

Range: 0.00 ohms to 700.00 ohms
Accuracy: ± 0.10 ohm
Resolution: 0.01 ohms
Type Wiring: 3 or 4 wire RTD configuration
Excitation Current: 1 mA
Maximum Compensation Lead Resistance: 100 ohms
Span Drift: 25 ppm/°C of reading

MILLIAMP INPUT MODE

Range: −9.990 mA to 90.000 mA (input-display)
Resolution: 0.001 mA (1 µA)
Shunt Resistance: 10 ohms
Span Drift: 50 ppm/°C of reading
Accuracy: ± 0.010 mA

MILLIAMP OUTPUT MODE

Range: 0 to 50.000 mA continuously adjustable
Maximum output load resistance:
480 ohms @ 50 mA
1200 ohms @ 20 mA
4800 ohms @ 5 mA

Adjustment: Coarse and fine membrane switches for adjustment over entire span with 1 µA resolution

VOLTAGE INPUT MODE

Range: −9.990 to 30.000 volts DC input display
Resolution: 0.001 Volts (1 mV)
Inputs Impedance: 10 megohms
Span Drift: 50 ppm/°C of reading
Accuracy: ± 0.01 volts

VOLTAGE OUTPUT MODE

Range: 0 to 10 volts DC continuously adjustable
Load Resistance: not less than 1000 ohms
Adjustment: Coarse and fine membrane switches for continuous adjustment over entire span with 1 mV resolution

RESISTANCE OUTPUT: From 18.0 Ω to 500 Ω using 070206 RTD Simulator.

Accuracy of Outputs: Same as input accuracy.

HOW TO ORDER

	Price
Specify: L&N 9696 Calibrator/Tester Part No. 070205★) 9696 Calibrator/Tester with self-contained battery-pack and recharger for 115 VAC service. Includes RTD Simulator Module (**Part No. 070206**), recharger line cord and operator's manual.	**$2290.00**

ACCESSORIES

Part No. 070207★ 12-point Thermocouple Selector Switch Module has 12 sets of screw terminals to accept 12 thermocouple or copper (mV) lead pairs. Module plugs directly into TC/MV input terminal posts on Cat. 9696.	**155.00**
Part No. 070206★ RTD Simulator Module plugs directly into RTD terminal posts of Cat. 9696. Coarse and fine adjustments allow setting a resistance value as measured by the Cat. 9696. A transfer switch allows set resistance value to be applied to an external instrument simulating an RTD. Range is 18.0 µ to 500 µ.	**175.00**

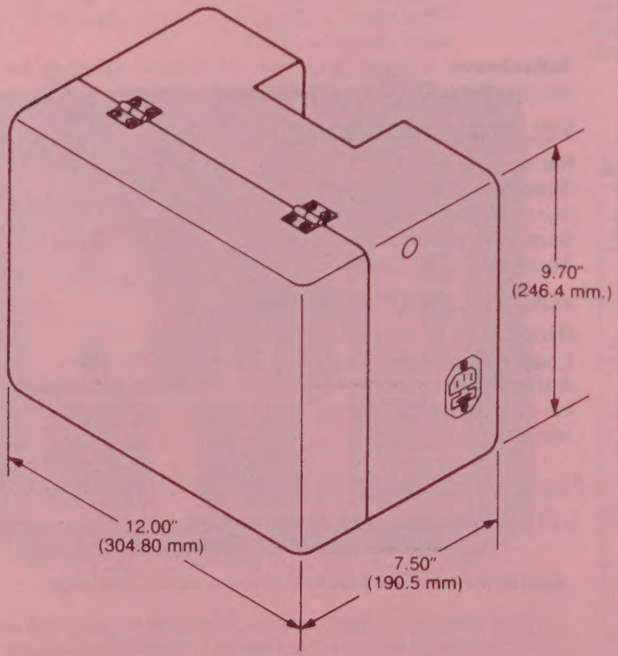
ACCESSORIES (Cont.)

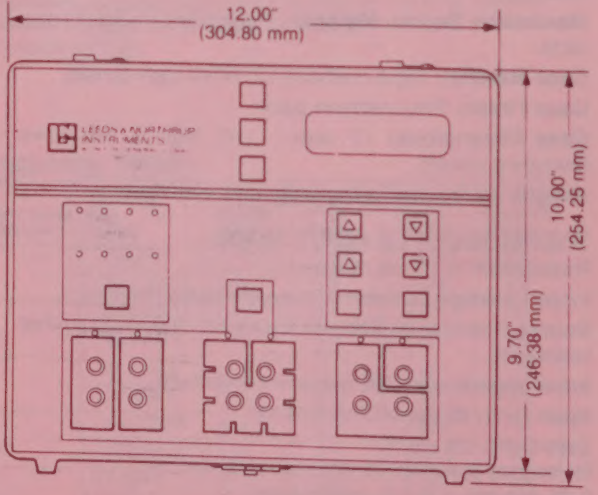
	Price
Part No. 070208★ Nylon carrying case for the L&N 9696 Calibrator/Tester.	**$ 130.00**
Part No. 070236 Replacement Battery Pack. (Not Stocked, 4 weeks delivery.)	**98.00**
Part No. 277732★ Directions	**6.00**
B0.1115-DS Data Sheet	**N.C.**

★ Items stocked at North Wales.

Sales Note: The Cat. 9696 Calibrator/Tester is manufactured for Leeds & Northrup Instruments, Unit of General Signal by Thermo Electric Instruments, Saddle Brook, N.J. For repairs and warranty service, contact Repair Office at North Wales.

DIMENSIONS





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